Stream Inventory Handbook

Level I & II

Appendix Reference in Text

Pacific Northwest Region

Region 6
1999 ~ Version 9.9

STREAM INVENTORY HANDBOOK

Version 9.9

MAY 1999

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION/OVERVIEW

BACKGROUND

Periodic, recurring inventories are an integral part of the fish habitat and watershed management programs and form the foundation for effective program management. Inventories should produce comparable information, both between administrative units, as well as across time. They will generate the baseline information that will be used to support a variety of management activities, including, but not limited to; watershed analysis, timber sales, range allotments, special use permitting, and fish habitat and watershed restoration programs. They will also serve as the basis for stream monitoring and evaluation programs. Specifically, inventories will identify existing aquatic and riparian conditions, identify factors limiting the productive capabilities of habitats, measure attainment of meeting stream habitat objectives, and help to assess cumulative watershed effects. The inventories can be used to monitor and refine Land Management Plan Standards and Guidelines.

The Pacific Northwest Region (Region 6) stream inventory is designed on a hierarchical scale to provide the user the opportunity to choose an inventory protocol which meets the data needs for asked questions. Level I is the basic in-office procedure which identifies standard attributes of the watershed/stream to be analyzed. Its primary objective is to document and consolidate sources of general knowledge of the stream system. Level II is an extensive stream channel, riparian vegetation, and aquatic habitat condition inventory on a watershed-wide scale. This level is to be used to determine the "pulse" or condition of a system during low flow conditions. Level III is an intensive field inventory designed specifically to answer a particular question (i.e., monitoring, project level planning and project design, etc.). Level IV is a very intensive field inventory of stream or riparian conditions, water quality and quantity, riparian habitat, aquatic habitat, and fish populations. This level is used to answer basic research questions or to validate management decisions.

This handbook provides standards for both the level I (office inventory) and level II (field inventory). A level II inventory requires the completion of a level I as a prerequisite. The protocol identifies core attributes which are necessary to evaluate the condition of the stream (mandatory for collection), and non-core, Forest optional attributes. Forests have the flexibility to add attributes to the protocol to meet their needs; however, unit costs and target allocations/accomplishments will be based on the Regional protocol.

Region 6 has produced a recommended protocol for level III inventories, but the methods are not included in this handbook. By contrast, it is recognized that a standardized approach to level IV is inappropriate due of the large variation in data needs that exist. Therefore, procedures for level IV are open to development at the District, Forest, or research unit level.

The purpose of both the level I and level II inventories is to identify existing stream channel, riparian, and aquatic ecosystem conditions on a watershed scale. As inventories are completed and repeated over time, the information generated by them can be useful in measuring changes in stream channel conditions and determining attainment of habitat management objectives, provided stringent quality control administration occurs. In this context, the inventory can be applied as a basic "monitoring" tool.

INVENTORY ATTRIBUTES

Key attributes of the Region 6 level I and II stream inventories were developed considering the following concepts:

Driven by questions that are to be addressed. Identification of management questions formed the basis for the content of the inventory. The ability to address questions consistently and comparably across units has been demanded of the United States Department of Agriculture, Forest Service (FS) by both users and managers of the resources. Inventory and analysis procedures were developed to provide the information necessary to answer those questions.

Contains a consistently applied set of core attributes. The level I and II inventories contain data attributes that were identified by an interagency interdisciplinary team as the most critical for defining stream channel, riparian vegetation, and aquatic resource condition. The core data attributes are likely to be key elements in any future inventory process and can be used to drive a number of aquatic/channel classification systems.

Quantifiable through direct observation. Where practicable, the level II inventory generates quantitative estimates of channel conditions and habitat attributes.

Statistically valid approach. The level II inventory meets assumptions for standard statistical analysis and results in estimates with known boundaries of error for habitat unit dimensions. It follows a stratified random sampling design and permits extrapolation of known, measured attributes throughout the watershed.

Repeatable. This protocol provides a statistically defensible method for evaluating and minimizing the observer bias inherent in the visually estimated dimensions for habitat units. Quantitative measures for streamflow, bankfull channel dimensions, bank instability, and substrate are intended to further reduce surveyor bias and sampling error. These considerations are intended to reduce the inherent variability surrounding many of the attributes so that replication of sampled attributes will be meaningful across time and space.

Coordinated with other resource areas and management entities. The procedures for these inventories represent an integrated approach between FS watershed and fisheries disciplines in defining stream channel, riparian vegetation, and aquatic resource conditions at the watershed scale. It has been reviewed and is compatible with similar aquatic inventories developed by state agencies, specifically the Oregon Department of Fish and Wildlife (ODFW) and Timber, Fish and Wildlife (TFW) in Washington State. It has been developed as the aquatic companion to the FS Integrated Resource Inventory (IRI), and is comparable with other FS stream inventories developed in Regions 1, 4, and 5. It contains the recently completed "Core Data Standards" developed by an interagency team for implementation of the Northwest Forest Plan.

Cost efficient. The Region-wide average cost to complete this survey is $1,000 per mile. Local conditions such as stream size, channel complexity, location, etc. and contracting of services contribute to a range of costs around this value. These estimates include data collection, data entry, analysis, and report writing. Costs can be considerably higher as Forests add optional attributes that are not considered in the annual allocation of funds from the Region.

ESTABLISHING FOREST PRIORITIES

The stream inventory program is an institutionalized component of the fisheries and watershed programs. A rate of 10 percent of fish-bearing streams per year is prescribed and offers a program that is responsive to management needs. This infers a 10-year re-inventory recurrence interval for all fish-bearing streams.

Forests should consider the following factors in setting priorities for stream inventory:

- Tier 1 and Tier 2 Key Watersheds where Watershed Analysis is to be completed in the near future.
- Sensitivity of fish stocks present.
- Habitat/watershed vulnerability or sensitivity; watersheds that are particularly vulnerable or sensitive to management activities should be a high priority.
- Level of planned activity in the watershed.
- Management plan development (e.g., Wild and Scenic Rivers designation) or agency coordination/cooperation.
- Relative importance of a watershed in terms of fish production or use.
- "Representativeness" of a watershed to others for stratification and extrapolation of information to those systems that are lower priority.
- Size/feasibility of detecting change and managing that change (i.e., it is more difficult to detect change in larger systems and frequently more difficult to mitigate those effects).
- Wilderness or watersheds representing intact, hydrologically functioning systems; to be used in developing numeric ranges for attributes which quantify "Desired Future Conditions."

STREAM INVENTORY PROGRAM MANAGEMENT

Data management. The Stream Management, Analysis, Reporting and Tracking (SMART) database program was developed as an ORACLE application on the IBM system to facilitate the sharing of information between units and to support Regional efforts to integrate level II inventory information into the Geographic Information Systems (GIS) environment. Three different methods can be used to input data into the SMART database: the IBM SMART program, the Stream Data Recorder (SDR) program, and importing an ASCII file through the walkabout Load subroutine. Regardless of which method is used to input data, all level II stream inventory data will be stored within the corporate IBM SMART database.

A series of standard summary tables has been developed within the SMART program.

The tables provide the basic information necessary to characterize stream condition, habitat, and function. Forests and Districts are encouraged to do additional data analysis to explore specific habitat relationships and develop more effective ways of presenting the information. Additional analysis can be done most efficiently by downloading the stream inventory data into a personal computer (PC) environment.

PROGRAM ADMINISTRATION AND QUALITY CONTROL

Stream inventory data are increasingly used to make significant resource management decisions. As such, the reliability and credibility of the information is paramount. Past program reviews have identified potential problems in program management and significant changes have occurred to address these deficiencies. In order to ensure the highest quality of information is provided through the inventory, program and quality control standards have been developed. The following items should be viewed as minimum standards in the annual implementation of the program.

<u>Program Administration</u>

- ☞ Forest and District Program Managers ensure data are collected according to standard protocol, the data analyzed, and reports written in a timely fashion.
- ☞ Forest and District Program Managers will develop an operational understanding of the inventory protocols.
- ☞ Either the Forest hydrologist or fisheries biologist will attend the annual Regional training session.
- ☞ Each Forest will establish a stream inventory quality control contact person.
- ☞ Each Forest will supplement Regional training with Forest-level training and orientation to ensure comprehension and proper application of the Regional inventory procedures.
- ☞ Each Forest will develop a "test reach" as part of Forest-level training.

<u>Pre-Inventory Training Phase</u>

- ☞ Each survey member will be given a handbook for review and will be accountable for techniques and terms.
- ☞ The context of the level II in the four level hierarchical inventory program will be understood.
- ☞ Training in basic map and air photo interpretation for each surveyor will be documented.
- ☞ Training in the use and maintenance of necessary equipment for each surveyor will be documented.

<u>Field Inventory Training Phase</u> -- Prior to the field season, all crews will have review on:

- ☞ How to complete all field forms.
- ☞ How to take a measured streamflow.
- ☞ How to establish and place temperature recording devices.
- ☞ How to make bankfull determinations.
- ☞ How to conduct a Wolman pebble count.
- ☞ How to sample fish populations and correctly identify fish species.
- ☞ How to check data sheets to catch chronic data recording errors.
- ☞ How to reduce observer bias in estimates of habitat dimensions.

Post-Inventory Training Phase

- ☞ How to error-check recorded data.
- ☞ How to correctly label slides and photographs.
- ☞ How to develop final inventory maps.
- ☞ How to analyze SMART reports.
- ☞ How to write draft reports.

PRESENTATION OF INFORMATION

The preferred format for summarizing and presenting stream inventory data is the stream inventory report. It contains two basic components which provide information in a legible, understandable format to two distinct audiences: Line and Staff personnel within the FS and the technical specialists.

The executive summary highlights the condition and identifies the issues, concerns, and opportunities within the watershed for line and staff. The target audience for the main body of the report is the technical specialist. It contains summaries of the quantitative data collected as well as field observations and the resulting conclusions on stream condition, habitat interrelationships, and potential factors limiting fish production. The information is summarized at both the reach scale and the drainage basin scale.

The foundation for every report resides in sound interpretation of the available historic data wedded to habitat information obtained during the field inventory. Rather than merely a regurgitation of numbers and figures in the summary tables, interpretation should include investigating the interrelationships that exist between the data attributes (e.g., number of channel-width pools per mile, number of functional pieces of large woody debris (LWD) larger than 24 in. diameter per mile, stream reaches where stream temperature exceeds state standards). Correlations of pools per mile to riparian vegetation condition and to the amount of large woody debris can aid in identifying potential habitat deficiencies in aquatic systems. These same relationships offer an indication of rehabilitation potential for a stream and its riparian vegetation.

Although basic data interpretation can be completed by the individuals conducting the stream survey, all reports should have journey-level fish biologist or hydrologist review and concurrence. The section of the report addressing management implications should be written by the journey-level professionals. A good understanding of the interrelationship of the physical and biological conditions of a stream is needed in order to develop sound, realistic management interpretations and recommendations.

HANDBOOK CONTENT

The Stream Inventory Handbook provides instructions for conducting the level I and level II stream inventories. It contains three sections: Office Procedures (level I), Field Procedures (level II), and Appendices.

User's Guides for both the SMART database and for the Stream Data Recorder (SDR) program are issued as separate documents.

Office Procedures: This section contains the specific instructions for completing the office phase, or level I inventory. Information collected from the office phase is placed on Form A and Form B1. The purpose of completing Form A is to familiarize the surveyors with the historical use and natural history of the landscape drained by the inventoried stream. The purpose of completing Form B1 is to delineate preliminary stream reaches and create a field map which includes access points for the field inventory. The field phase (level II) will validate or amend the reaches first delineated on Form B1. Form B1 will be retained with the stream folder as documentation of the level I inventory.

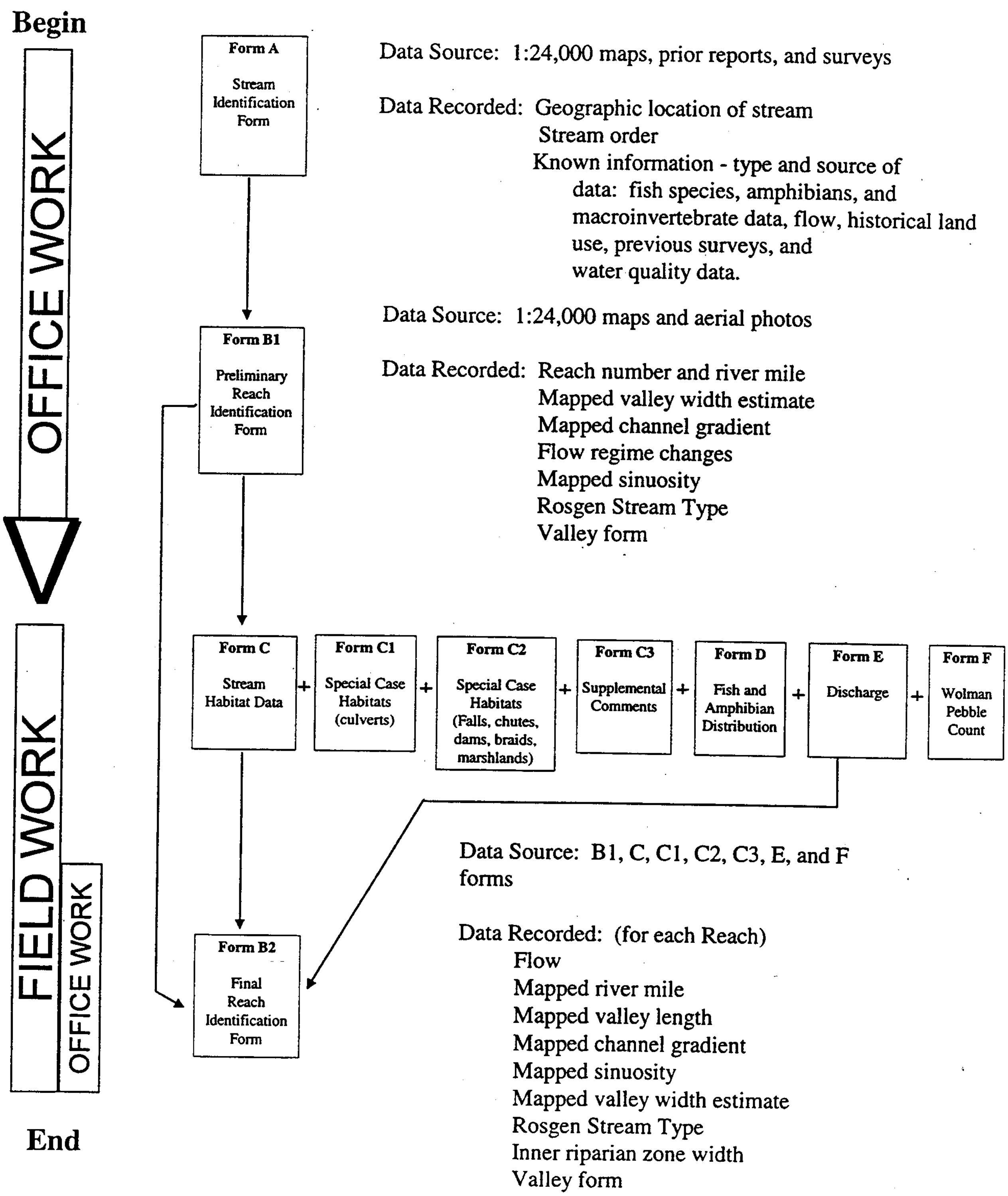
Field Procedures: The field phase (level II) is the nuts and bolts of the stream inventory process. The level II utilizes Forms B2, C, C1, C2, and C3 which are used to gather information on the physical attributes of the stream and its riparian forest. Form B2 also has attributes which are derived from field data, but are more easily completed in the office. Form D documents fisheries information, Form E records stream discharge, and Form F is used to characterize the streambed substrate in riffles. Data gathered during the field phase is used to assign a letter designating the dominant Rosgen Stream Type of each reach.

Appendices: The appendices contain specific information that support a number of the data attributes collected in both the office and field phases.

Forms: A total of 10 forms are completed as part of the inventory. These clean copies are provided as masters from which to make your working copies. **Please note**: Waterproof, smudge-proof forms can be developed by using opaque transparencies rather than paper as the base medium. These are relatively inexpensive, and can be mass produced on most photocopy machines.

The following figure presents a view of the inventory process which includes a timeline and flow chart outlining the relationship between the suite of forms used in the course of completing a stream inventory.

Figure 1: Flowchart showing the order that Data Forms are used



CHAPTER 2

OFFICE PROCEDURES: LEVEL I INVENTORY - IDENTIFICATION LEVEL

OBJECTIVES. The objective of the office phase is to provide the field crews with a general introduction to the stream targeted for inventory. This is accomplished through assembly and summarization of any data that has been previously collected for the basin. This information will be used to tentatively stratify the stream into stream order and stream reaches. A reach is a relatively homogeneous section of stream that contains attributes of common character. Review of the information compiled by the office phase will be extremely valuable in selecting sampling intervals for measured habitats, planning stream access logistics, summarizing initial hydrologic information, and initially identifying perennial and fish-bearing streams. The statistical validity of this inventory process was first described in "Estimating total fish abundance and total habitat area in small streams based on visual estimation methods" (Hankin and Reeves 1988).

Aerial photo analysis and the use of maps of suitable scale (i.e., 1:24,000) will enable the survey team to identify, at an acceptable level of resolution, such attributes as mapped channel gradient, mapped sinuosity, vegetative types in riparian and upslope areas, watershed acres, floodplain widths, tributary confluences, and watershed characteristics. The maps assembled during this process will be of great value to the crews in the field. An effective field map(s) will show tributary streams, road crossings, access points, and general location of notable geologic features and unique characteristics. These characteristics will be used by the field crew to accurately locate reach breaks and features in the basin. The Geographic Information System (GIS) technicians operating at Ranger Districts and Forest offices can often provide high quality analysis of the present condition of the surveyed stream's drainage basin.

STANDARDS. The office phase level I inventory will provide information only as accurate as the scale and accuracy of the maps, photos, and previously collected data. Accuracy will also be affected by the human error introduced when measuring the attributes required. At a minimum, use 1:24,000 scale USGS topographic maps. Any measurements should be confirmed with a map wheel, dot grid, or other standard method of measurement.

EQUIPMENT/INFORMATION NEEDED.

- ✎ Topographic Maps/Aerial Photos--Scale of 1:24,000.
- ✎ Planimeter/Map Wheel.
- ✎ Calculator.
- ✎ Watershed Codes from FSH 2509.24.
- ✎ Hydrological Data--flow, temperature, turbidity, macroinvertebrate, etc.
- ✎ Geological Information--Geological province, landform type, etc.
- ✎ Historical Land Use Information.
- ✎ Past Stream Surveys--US Bureau of Fisheries, FS, USDI Bureau of Land

Management (BLM), State, etc.
✎ Level I Inventory Forms - Office Phase.
Form A - Stream Identification Form.
Form B1 - Preliminary Reach Identification Form.

PROCEDURE. The office phase requires the completion of Forms A and B1. Much of the information for Form B1 can be collected from aerial photos, orthophotographs, and 1:24,000 scale USGS topographic maps. Each attribute is identified in **BOLD** text and is followed by instructions on how to measure or collect information on the attribute.

At the end of each attribute discussion, a character or numeric field length for each data attribute entered to the SMART database is given in the form: **(FL:3 (e.g., 99.9))**. In this example, SMART will accept a numeric-only entry for this attribute which cannot exceed 99.9 ft. in magnitude, but can include a measured value to the nearest tenth of a foot.

PLEASE NOTE THAT THE INSTRUCTIONS FOR COMPLETING THE HEADER FOR EVERY FORM USED IN THE LEVEL I AND LEVEL II INVENTORIES ARE LISTED ONLY IN THE SECTION OF CHAPTER 2 LABELED "FORM A INSTRUCTIONS." ATTRIBUTES A THROUGH H ARE THE SAME FOR EVERY FORM. Where additional header information is required, specific instructions are given for that form.

Should questions arise concerning any phase of the inventory process, consult with the local hydrologist and/or fisheries biologist. It is their role to supply answers and clear direction during the inventory process.

PRODUCTS. A level I inventory (office phase) shall be completed for every stream designated for a level II inventory. The level I process will produce:

✎ A list of existing information previously collected on the stream and drainage basin.
✎ A completed Form A.
✎ A completed Form B1.
✎ A draft copy of a 1:24,000 scale USGS topographic map of the target stream that shows preliminary reach breaks, access points, road crossings (culverts, bridges, etc.), known dams and diversions, and other points of interest that will help orient the field crews to the stream to be inventoried. Forests are encouraged to develop and adopt a consistent set of map symbols which encode channel and riparian conditions of concern to the management of each Forest.

STREAM IDENTIFICATION - FORM A, R6-2500/2600-10.

FORM A INSTRUCTIONS

A. STATE: Enter the appropriate 2-letter code:
Oregon...........OR
Washington....WA
California........CA
(FL:2 (e.g., ZZ))

B. COUNTY: Uses FS-ATLAS national standard. (FL:3 (e.g., 999))

C. FOREST: Enter appropriate two digit code for the Forest. (FL:2 (e.g., 99))

D. DISTRICT: Enter appropriate two digit code for the District. (FL:2 (e.g., 99))

E. STREAM NAME: Enter the name of the stream inventory, limiting the length of the name to 40 characters. Some Forests begin the stream name with the 5th field watershed code, followed by the stream name, followed by the year surveyed. (FL:20 (e.g., 21 Salmon Creek 96))

F. WATERSHED CODE: Refer to FSH (Forest Service Handbook) 2509.24 to determine the correct Hydrologic Unit Code for the watershed. Enter only the first four 2-digit fields (Hydrologic Region, Hydrologic Subregion, Accounting Unit, and Cataloging Unit). Refer to Appendix A for a more detailed explanation. (FL:8 (e.g., 99,99,99,99))

NFS CODE: Contact your hydrologist or GIS specialist for assistance in correctly identifying the NFS code. (FL:3 (e.g., 99,A))

If the section of stream to be inventoried does not begin at the mouth of the largest stream in an National Forest System (NFS) Subwatershed, enter the map wheel-measured river miles from the mouth of the largest stream in that Subwatershed to the confluence with the stream targeted for inventory. This river mile distance is measured with a map wheel along the "blueline" stream channel defined on a 1:24,000 scale USGS topographic map. Up to four mileage entries can be used to identify the specific stream if necessary. See Appendix A for a more detailed explanation on how to determine the stream mileage identifiers. (FL:4 (e.g., 999.99, 99.99, 99.99, 99.99))

G. USGS QUAD: Enter the name of the registered USGS Quadrangle containing the stream mouth or point where it leaves the Forest. This is the 1:24,000 (2.64-inch) scale USGS topographic map. (FL:60 (e.g., Sinker Mountain))

H. SURVEY DATE: Enter the date the field survey began. Be sure it is the date actual level ii initiated using the following format: DD-MMM-YY. (e.g., 01-JUL-95).

I. NAME: Persons filling out Form A will record the initial of their first name as well as their complete surname (e.g., J.Smith). <u>NOTE</u>: This attribute **WILL NOT** be entered into the SMART database version of Form A.

1. WATERSHED AREA: Calculate the area of the basin above the mouth of the target stream to the nearest 250 acres. If the inventory begins at a point upstream from the mouth, determine the drainage basin above that point. This measurement is made on a 1:24,000 scale USGS topographic map by first identifying the ridge lines that define the drainage basin, and then calculating the area using a dot grid or planimeter. Consult your GIS experts since they can calculate watershed area more accurately through digitizing the area. If GIS is available, record watershed area to the nearest 10 acres. (FL:6 (e.g., 999,990))

2. STREAM ORDER: Utilizing the Strahler method, identify stream order (see Appendix B) of the lowest most reach. A first order stream is the smallest fingertip "blueline" tributary. A first order channel can appear as either a dotted or solid "blueline" channel on a 1:24,000 scale USGS topographic map. (FL:1 (e.g., 9))

3. FISH AND AMPHIBIAN SPECIES AND DATA SOURCE: Starting from the left, record dominant or management-emphasis fish species as well as any threatened, endangered, or sensitive amphibian species known to be in the basin. The species codes consist of the first two letters of the genus and the first two letters of the species names. See Chapter 3 for a list of the standard species codes for freshwater fishes and amphibians of Washington and Oregon. If no data exist, write "Nothing on record." (FL:240(e.g., ONTS, ONKI, ONMY, ONCL))

4. FLOW DATA: Enter in narrative form, the historical flow data available for the stream. List all sources, such as USGS gauging stations, Forest monitoring sites, IFIM studies, etc., and the dates that data were collected. If no data exist, write "Nothing on record." (FL:240 (e.g., USGS Gaging Stn. #14146500 is located 0.2 RM from mouth; ave. flow for JUL = 260 cfs)).

5. WATER QUALITY DATA: Review files for any quantitative physical or chemical data. Reference the type and source of information and year data were collected. If no data exist, write "Nothing on record." (FL:240(e.g., ODFW max/min stream temp. during JUN-SEP: 1970-88))

6. MACROINVERTEBRATE DATA: Enter, in narrative form, the type and source of previous information on the presence, distribution, and abundance of macroinvertebrates in the stream to be inventoried. Examples include analysis conducted by the Aquatic Ecosystem Analysis Lab, local forest studies, etc. If no data exist, write "Nothing on record." (FL:240 (e.g., 1990 survey by Taxon, Inc. reported that chironomids comprised 65% of the biomass in pools and riffles, and the remaining 35% were split relatively evenly among six other insect taxa.))

7. PREVIOUS SURVEYS: Reference the source of the information, level of survey, and year accomplished. If no data exist, write "Nothing on record." (FL:240 (e.g., 1965 Blue River RD survey of culverts included the three culverts on this stream.))

8. HISTORICAL LAND USE DATA: Record here any useful historical information you have accumulated regarding activities in the drainage basin and stream network (e.g., old photos, interviews on file, splash dams, mining, literature, etc.). Also review the Forest's Historical Land Use Atlas -- see an Archeologist for this document. If no data exist, write "Nothing on record." (FL:240 (e.g., Railroad built in 1930-33 for logging. Rails removed and railbed rebuilt as sealed road in 1965, active logging in upland since 1965, and map of units by age of cut is available.))

9. COORDINATION: Verify participation or coordination with other agencies or interest groups for the present inventory. Explain the groups participating and their work to be accomplished. (FL:240 (e.g., WDFW will inventory the private land sections of the stream, has agreement with owners, will use R06 protocol.))

10. COMMENTS: Use this space to elaborate on the above attributes. Note apparent watershed problems, special features or habitats, fish stocking information, management problems, studies, critical habitats, special land allocations, etc. (FL:240 (e.g., 45% of drainage basin is in private hands, permission has been denied for inventory of stream through Clark Timber Co. lands.))

PRODUCTS OF FORM A PROCESS

1. Completed Form A.
2. Review of available historical records and information on the drainage basin in which the stream to be inventoried is found.

STREAM HABITAT DATA FORM A
R6-2500/2600-10

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ______________________________

F. Watershed Code ___, ___, ___, ___ NFS ___,___;___.___,___.___,___.___,___.___

G. USGS Quad ______________________________

H. Survey Date ____-______-____ I. Name ______________________________

DD-MMM-YY

1. Watershed Area ____________________ Acres
2. Stream Order ____________________
3. Fish and Amphibian Species _____,_____,_____,_____,_____,_____,_____,_____

   Data Source ______________________________

4. Flow Data ______________________________
5. Water Quality Data ______________________________
6. Macroinvertebrate Data ______________________________
7. Previous Surveys ______________________________
8. Historical Land Use Data ______________________________
9. Coordination ______________________________
10. Comments ______________________________

PRELIMINARY REACH IDENTIFICATION - FORM B1, R6-2500/2600-20

Form B1 is used to stratify the stream into preliminary reaches. This will be done with information gleaned from the topographic maps, orthophotographs, aerial photographs, and/or GIS layers. Characteristics which should be used to initially select stream reach breaks are changes in: mapped valley width estimates, channel gradients, sinuosity, and streamflow due to large tributaries (see figure 2). These reach breaks should closely correspond to the level I Rosgen Stream Types (i.e., Aa+, A, B, C, D, DA, E, F, G), but the minimum length for all reaches is 0.5 miles. Development of a longitudinal profile from the 1:24,000 scale USGS topographic map will identify major gradient changes for establishing starting and ending points for each reach.

These reach endpoints will be verified, refined, or modified by the field crew during the level II (field phase) inventory, and these field-verified reaches will be accurately translated onto the field maps and/or aerial photographs. When the field portion of the reach inventory is complete, the information from Form B1 will be used to complete Form B2; once Form B2 has been completed, Form B1 will be retained in the stream folder as originally completed.

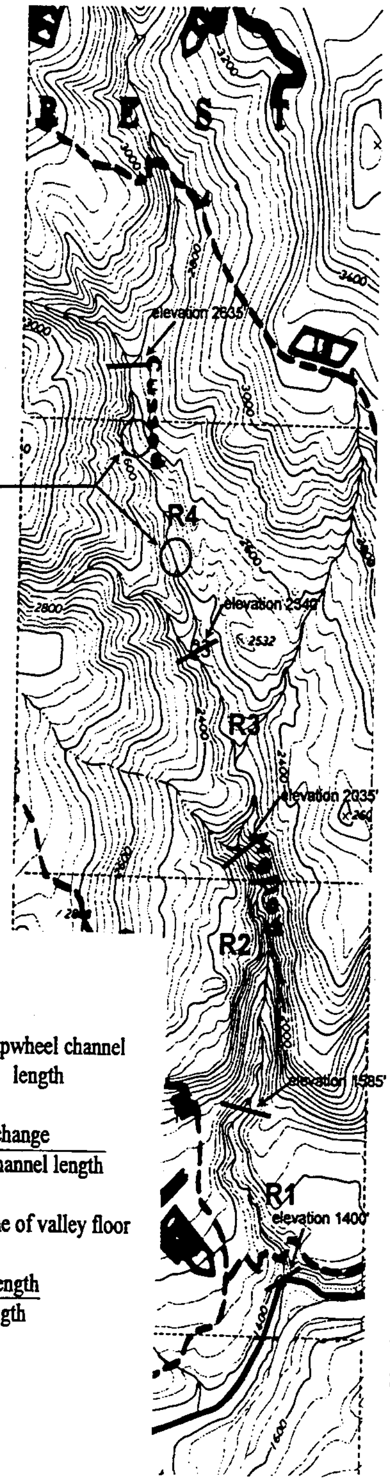
NOTE: Form B1 data will not be entered into the SMART data base.

FORM B1 INSTRUCTIONS

Fill out a Form B1 for each stream reach:

NOTE: INSTRUCTIONS FOR COMPLETING FORM BI HEADER (ATTRIBUTES A - H) ARE LISTED IN THE FORM A INSTRUCTIONS)

Figure 2: River basin characteristics derived from a 1:24,000 scale USGS topographic map



General area where you will do the pebble count in R4. (i.e., 1/3 and 2/3 of reach length.)

R4
Stream channel length = 3872 ft.
Mapped channel gradient = $\frac{(2635-2340)}{3872} \times 100 = 8\%$
Valley length = 3520 ft
Sinuosity = 3872/3520 = 1.1

R3
Stream channel length = 2816 ft.
Mapped channel gradient = $\frac{(2340-2035)}{2816} \times 100 = 12\%$
Valley length = 2640 ft
Sinuosity = 2816/2640 = 1.1

R2
Stream channel length = 3520 ft.
Mapped channel gradient = $\frac{(2035-1585)}{3520} \times 100 = 13\%$
Valley length = 3168 ft
Sinuosity = 3520/3168 = 1.1

R1
Stream channel length = 2288 ft.
Mapped channel gradient = $\frac{(1585-1400)}{2288} \times 100 = 10\%$
Valley length = 1936 ft
Sinuosity = 2288/1936 = 1.1

mapped channel length = mapwheel channel length

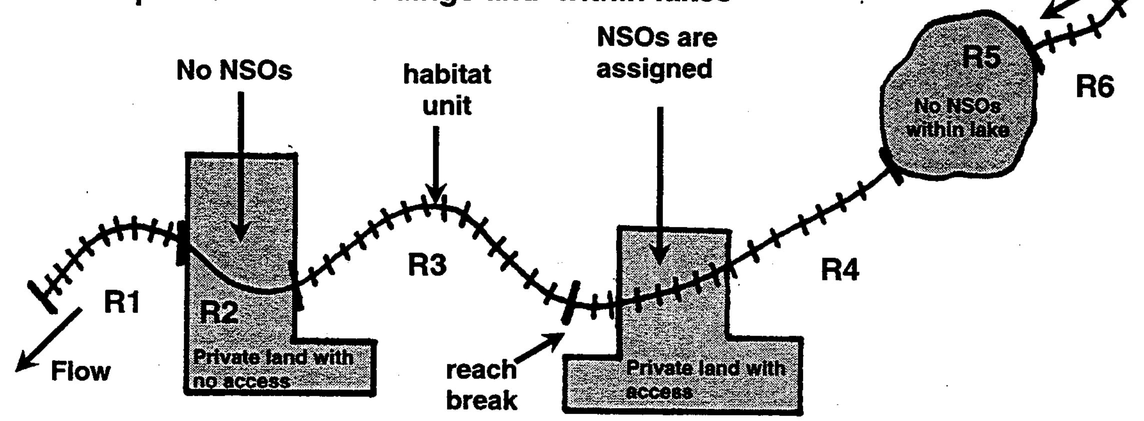
mapped channel gradient = $\frac{\text{elevation change}}{\text{mapped channel length}}$

mapped valley length = midline of valley floor

sinuosity = $\frac{\text{mapped channel length}}{\text{mapped valley length}}$

1. REACH NUMBER: Enter the reach number beginning at the lowest point of the proposed inventory. Number the reaches sequentially in an upstream direction. If access is denied to portions of the stream which are privately owned, treat the private land section as a separate reach (see figure 3). If permission to inventory the private land is secured, do not break out that portion of the stream as a separate reach. Whenever a lake occupies a valley section between two portions of the stream to be inventoried, treat the lake as a separate reach in a fashion identical to private land/no access. The pool upstream of a beaver dam is not a lake, and this pool is not considered as a separate reach. The pool upstream of a beaver dam is simply a pool habitat. Use standard geomorphic characteristics as described above to delineate the reach breaks in all other cases. Reaches that are less than 0.5 miles long are acceptable provided all riffles within the reach are treated as measured riffles.

Figure 3: Example of how NSOs are assigned (or not assigned) within private land inholdings and within lakes



2. MAPPED VALLEY WIDTH ESTIMATE: Enter the estimated average width of the floodplain or valley bottom as determined from the 1:24,000 scale USGS topographic maps and from aerial photographs. An estimate is made for each reach.

3. FLOW REGIME CHANGE: Note any large tributaries to the inventoried stream. These may offer excellent reach breaks if the tributary drains a basin similar in area to the drainage basin of the inventoried stream upstream of the confluence with the tributary. Reaches can be stratified by significant changes in flow, while other variables remain the same. Enter yes Y or no N if this is used for reach delineation purposes.

4. MAPPED CHANNEL LENGTH: Using a map wheel, determine the "blueline" channel length between the preliminary reach breaks for each reach.

5. MAPPED CHANNEL GRADIENT: Use GROSS changes in gradient to develop preliminary channel reach breaks. Long homogeneous lengths of similar gradient may delineate a reach. However, other attributes can temper the stratification. Channel gradient for Form B1 will be calculated by dividing the elevation gain (high elevation contour minus low elevation contour) by the mapped channel length for each reach.

6. MAPPED VALLEY LENGTH: Enter the estimated valley length determined from the 1:24,000 scale USGS topographic maps. Mapped valley length is defined as the distance along the midline of the valley floor between the endpoints of a reach. Similar to mapped channel length, the measurement for valley length is made with a mapwheel. It is not a straight line between reach breaks. Instead, mapped valley length is a curved line connecting the topographic contours as they cross the valley floor.

7. MAPPED SINUOSITY: Enter the estimated sinuosity for the delineated reach. This is calculated by dividing the mapped channel length between reach endpoints by the mapped valley length between the same reach endpoints.

8. ROSGEN STREAM TYPE: Use the values derived from the investigation of the 1:24,000 scale USGS topographic maps and aerial photographs to assign a level I Rosgen Stream Type to each preliminary reach. Previous inventories on the same stream channel may provide additional insight concerning potential reach breaks.

9. VALLEY FORM [Forest Option]: Enter appropriate code (1-10) that best describes the valley form. Examples are: wide, glaciated U-shaped valley; steep, narrow V-shaped valley; broad, flat plain; alluvial outwash; etc. (See Appendix C).

PRODUCTS OF FORM B1 PROCESS

1. Completed Form B1 which includes a preliminary Rosgen Stream Type[1] for each reach.
2. Field-ready 1:24,000 scale USGS topographic map identifying preliminary reach breaks, private land holdings, and potential access points.

[1]Reference: Rosgen, D.L. *Applied River Morphology.* Wildland Hydrology, 1996.

STREAM HABITAT DATA FORM B1 Page: ____ of ____
R6-2500/2600-11

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ____________________

F. Watershed Code ___, ___, ___, ___ NFS ___,___.___,___.___,___.___,___.___

G. USGS Quad ____________________

H. Survey Date ____-______-____
DD-MMM-YY

1. Reach Number ______ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ________ 4. Mapped Channel Length ________ 5. Mapped Channel Gradient ________ 6. Mapped Valley Length ________ 7. Mapped Sinuosity ________ 8. Rosgen Stream Type ________ 9. Valley Form (Forest Option) ________	1. Reach Number ______ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ________ 4. Mapped Channel Length ________ 5. Mapped Channel Gradient ________ 6. Mapped Valley Length ________ 7. Mapped Sinuosity ________ 8. Rosgen Stream Type ________ 9. Valley Form (Forest Option) ________
1. Reach Number ______ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ________ 4. Mapped Channel Length ________ 5. Mapped Channel Gradient ________ 6. Mapped Valley Length ________ 7. Mapped Sinuosity ________ 8. Rosgen Stream Type ________ 9. Valley Form (Forest Option) ________	1. Reach Number ______ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ________ 4. Mapped Channel Length ________ 5. Mapped Channel Gradient ________ 6. Mapped Valley Length ________ 7. Mapped Sinuosity ________ 8. Rosgen Stream Type ________ 9. Valley Form (Forest Option) ________
1. Reach Number ______ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ________ 4. Mapped Channel Length ________ 5. Mapped Channel Gradient ________ 6. Mapped Valley Length ________ 7. Mapped Sinuosity ________ 8. Rosgen Stream Type ________ 9. Valley Form (Forest Option) ________	1. Reach Number ______ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ________ 4. Mapped Channel Length ________ 5. Mapped Channel Gradient ________ 6. Mapped Valley Length ________ 7. Mapped Sinuosity ________ 8. Rosgen Stream Type ________ 9. Valley Form (Forest Option) ________

CHAPTER 3

FIELD PROCEDURES: LEVEL II INVENTORY - AQUATIC ECOSYSTEM INVENTORY

OBJECTIVES. The level II inventory is the basic tool for determining the quality and quantity of aquatic habitat and to obtain estimates of basic riparian and hydrologic conditions. The objective of the level II inventory is to provide a generally quantitative characterization of aquatic (fish/water) and riparian conditions at a watershed scale.

STANDARDS. Standards for the field phase are intended to obtain consistent quantitative data. Specific standards for the procedure to accomplish the level II inventory are listed below. Data collected shall be at least as accurate as specified in the Region 6 protocol presented in this handbook. All the attributes described in this protocol are mandatory, unless clearly stated as a "Forest option."

1. The observer is the field crew person assigned to make the visual distance estimates (habitat length, width, and depth). The observer must continue to make the estimates of habitat dimensions until there is a minimum of 10 measured pools and 10 measured riffles. Once this minimum number of measured habitats is attained, the observer can be replaced at the start at the start of the next reach. **DO NOT CHANGE THE OBSERVER MIDWAY THROUGH A REACH! IF A CHANGE IN OBSERVER IS NECESSARY, CHANGE AT THE START OF A NEW REACH BREAK! IF THE STREAM TO BE SURVEYED IS RELATIVELY SHORT (LESS THAN 2.0 MILES), IT IS IMPERATIVE THAT THE SAME OBSERVER MAKE ALL THE DISTANCE ESTIMATES FOR THE ENTIRE STREAM.** Following these directions is critical for establishing the correction factor for visual estimates vs. actual measurements for each observer.

2. **To develop statistically valid correction factors, a minimum of 10 pools and 10 riffles will be measured for <u>each</u> <u>observer</u> on each stream.**

3. On longer streams, where the required number of measured habitats is assured, the minimum sampling frequency for pool and riffle habitat units will be 10 percent. **On shorter streams, the frequency of measured units may need to be greater than 10 percent to achieve the minimum number of measured units as specified in #2 above.**

4. If a certain habitat type is uncommon (e.g., pools) 100 percent of those habitat units may have to be measured to achieve the required 10 measured units/habitat type. Consultation with the District hydrologist and/or fisheries biologist is highly recommended during the process of choosing a sampling frequency.

5. The first unit of each habitat type to be measured will be selected randomly. For example, if the team decides to measure pools at a frequency of 1:5, five playing cards (ace through five) are shuffled by the recorder. The observer then selects one of the cards **WITHOUT LOOKING AT THE CARD'S VALUE,** and the recorder records the card

picked. To continue the example, if the recorder picks the "two," the first pool measured is the second pool in the survey (P2), and every fifth pool after the second pool is also measured (P7, P12, P17, P22, etc.). In a similar fashion, the sampling frequency for riffles is decided and the first measured riffle is randomly chosen. **There shall be no sampling of measured habitats at a frequency less than 10 percent. Do not roll dice to determine random starts.**

6. A long-term recording thermograph must be placed in a pool near the starting point (downstream most point of the survey in reach 1), and the thermograph must operate correctly between mid-June and late-September. The thermograph must be calibrated before installation. The device is then placed in the deepest part of the channel to ensure submersion as flows drop. The chosen site should not occur near the inflow from a cold spring where thermal mixing is questionable. A hand-held thermometer reading shall be taken at the time the thermograph is installed.

7. A system of photographs shall be established for the stream reach. The beginning, ending, and representative habitat types for each reach shall be photographed and documented, with a reference to NSO and habitat type photographed entered in the "Comments" section of Form C (or entered on Form C3).

8. A working map will be developed during the office procedure that will facilitate and expedite the field procedures' portion of the survey. This working map has been described in CHAPTER 2, OFFICE PROCEDURES: LEVEL I INVENTORY - IDENTIFICATION LEVEL (pages 8 and 9) of this manual. Field notes and observations shall be noted on this map, since this map will serve as the foundation for a final survey map to be included in the stream inventory report.

EQUIPMENT/INFORMATION NEEDED.

✎ Level II Survey Forms (Forms B2, C, C1, C2, C3, D, E, F), as appropriate.
✎ 30 cm ruler for Wolman Pebble Counts.
✎ Pencils.
✎ Clipboard.
✎ 1:24,000 scale USGS topographic maps.
✎ USGS quadrangle maps, orthophotographs, GIS stream layer maps, and aerial photographs
✎ 150-foot tape measures (an additional 150-foot tape measure may be necessary if the surveyed stream's flood prone zone is wider than 200 ft).
✎ Good quality, heavy duty scale stick or stadia rod.
✎ Camera.
✎ Water velocity meter.
✎ Long-term recording thermographs for each inventoried stream.
✎ Thermometer.
✎ Abney level, hand level, or peep site.
✎ Plastic strip flagging and grease pencil/marker for use as needed.
✎ Waders/Hip boots with felt or corkers.
✎ First Aid kit...a bee sting kit is a recommended element.
✎ Polarized sunglasses.
✎ Hardhat
✎ Radio.
✎ Snorkel, mask, wetsuit or drysuit.

✎ Backpack electroshocker.
✎ Bankfull pins and tension clamps (for measuring bankfull dimensions).

PROCEDURES. There are three phases needed to complete a level II survey: (1) preplanning before starting field work (see level I); (2) field measurements (field phase) which include reach location data and habitat data for every reach sampled (Forms B2, C, C1, C2, C3, D, E, and F); and (3) data entry, analysis, and summarization or reporting.

PRODUCTS. The level II inventory should produce:

✎ Completed Form B2s for each reach delineated during the field phase which will include a determination/validation of the level I Rosgen Stream Type for each reach.
✎ Completed entries to the appropriate field forms for each habitat assigned an NSO.
✎ At least one streamflow determination near the downstream end of the inventoried stream.
✎ An accurate field map (1:24,000 scale USGS topographic series) which labels reaches, tributaries, and other significant features discovered during the field phase.
✎ A completed stream data file in SMART which includes all entries made to Forms A, B2, C, C1, C2, C3, and D).
✎ A coherent stream inventory report that includes an executive summary, a basin summary, reach summaries, summary data tables; all of which should lead to sound data analysis and recommendations; these recommendations are an essential element of any level II inventory.

FINAL REACH IDENTIFICATION - FORM B2, R6-2500/2600-21

The purpose of Form B2 is to delineate the FINAL reach boundaries for the inventoried stream. The majority of the attributes on this form are calculated in the office and these are: mapped river mile, mapped valley length, mapped channel gradient, mapped sinuosity value, and the level I Rosgen Stream Type. A few of the attributes on this form are to be completed in the field as soon as the reach endpoint is determined, and these are: reach number, beginning and ending NSOs of the reach, inner riparian zone width, the observer, the recorder, and the completion date for the reach. Additionally, while still in the field, describe the reasons for ending the present reach in the "Comments" section of this form. (Additional comments can be entered to Form C3 if space is inadequate to address the reach delineation.)

It is mandatory that the field data for Form B2 shall be entered IN THE FIELD as soon as the reach endpoint is determined.

Reaches shall begin and stop on specific habitat units (i.e., pools and riffles) that are part of the mainstem stream and have accompanying natural sequence order numbers (NSOs). After those terminal units have been identified, final reach stratification can occur.

It is imperative to end and start all reaches at habitat units that can be specifically identified on the ground. Future surveys of the same stream will likely use the same reach end points provided they can be found. Photographs of each reach break will assist future surveyors locate the reach end points (e.g., stream tributary

confluence, waterfall, road crossing, cliff, etc.).

Again note that each observer must measure a minimum of 10 habitats of each habitat type **and** 10 percent of each habitat type they have observed per stream; hence, the number of observed/measured pairs is independent of stream reach. Once an observer has committed to calling a reach, they must complete it.

Fill out a Form B2 for each stream reach.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM B2 HEADER (ATTRIBUTES A - H) ARE LISTED IN THE FORM A INSTRUCTIONS

FORM B2 INSTRUCTIONS

1. OBSERVER/RECORDER: Using a first initial and surname format (e.g., S.SWEET), enter the name of the observer. This person must make all the visual estimates of habitat width and length for the entire reach. Enter the name of the person recording for the reach using the same format.

2. DATE: Enter the date that the level II inventory on the reach was completed. Use the format DD-MMM-YY (e.g., 23-JUL-95).

3. REACH NUMBER: Enter the reach number beginning at the downstream end (or startpoint) of the inventoried stream. Stream reaches are incremented sequentially in an upstream direction. (FL:3 (e.g., 999))

4. NATURAL SEQUENCE ORDER (NSO): Enter the starting and ending NSOs for each reach **(e.g., Reach 1 = NSO 1-55, then Reach 2 = NSO 56-126, etc.).** This information is extracted from Form C, following final reach delineation. In the case of private land where no access has been granted, DO NOT assign any NSOs for the reach (enter 0), resume sequential NSO numbers at the next reach. The following is an example of a stream crossing private land in which access has been denied: Reach 1, NSO = 1-203; Reach 2 (Private), NSO = (enter 0); Reach 3 (Public), NSO = 204-365, etc.). (FL:4 (e.g., 9999))

5. FLOW: Enter actual measured flow recorded in cubic feet per second. At a minimum, take one measured flow in the first reach near the starting point of the survey. If a tributary is estimated to contribute greater than 20 percent of the main channel flow and the reach length is at least 0.5 miles long downstream of the tributary, note approximate amount of flow in "Comments" and consider beginning a new reach. If additional measured flows are desired, they should be measured near the downstream end of each reach. See Chapter 4 of this handbook for instructions on determining streamflow. Record streamflow to the nearest 0.01 cfs. (FL:6 (e.g., 9999.99))

6. MAPPED RIVER MILE: Enter river mile (RM) at both the starting and ending point of each reach. Use designated Environmental Protection Agency (EPA) river miles if available. If the EPA river mile for the start of the survey is unknown, begin the mileage measurement at the mouth of the stream, starting with RM = 0.0. Whenever the starting point of a stream inventory is not at the mouth of the inventoried stream, the river mile location of the startpoint will reflect the actual distance of the startpoint upstream from the mouth of the surveyed stream. The ending river mile of the lower reach is the beginning river mile of the adjacent, upstream reach, (e.g., Reach 1: RM 0.0 to 1.1; Reach 2: RM 1.1

to 4.0; Reach 3: RM 4.0 to 5.2). Use map wheels to calculate river miles. The technique is to follow the "blue line" channel course as drawn on the 1:24,000 scale USGS topographic map. Reach length must be at least 0.5 river miles long to be considered a level II reach. Record to the nearest 0.1 RM. (FL:5 (e.g., 9999.9))

7. **MAPPED CHANNEL LENGTH:** Enter the mapwheel value for the field-verified channel length for the reach. Trace the line defining the stream channel on the 1:24,000 scale USGS topographic map.

8. **MAPPED VALLEY LENGTH:** The mapped valley length will be determined after the reach delineation has been verified or changed in the field. This is a valley line distance between the two endpoints of the reach, utilizing the 1:24,000 scale USGS topographical map and map wheel. The distance is determined by using the map wheel to trace an imaginary midline of the valley floor from the startpoint of the reach to the endpoint of the reach. Mapped valley length is not a straight line, but a curved line formed by connecting the topographic contours. These contours normally form a "V" or a "U" as they cross the valley floor. Record the value to the nearest 0.01 miles. (FL:4 (e.g., 99.99))

9. **MAPPED CHANNEL GRADIENT:** Calculate the mapped channel gradient for the reach from a 1:24,000 scale USGS topographic map once the final reach boundaries have been delineated. Subtract the river mile estimate for the upstream end of the reach from the river mile estimate for the downstream end of the reach to determine the mapped stream channel length. Estimate the elevations at the upstream and downstream endpoints of the reach by reading the contours on the map. Calculate the gradient by subtracting the lowest elevation from the highest, and dividing that change in elevation by the mapped stream channel length. Mapped stream channel length is a distance measured by tracing the "blueline" stream channel on a 1:24,000 scale USGS topographic map. Mapped stream channel length is the river mile length of the reach expressed in feet. (FL:2 (e.g., 99))

10. **MAPPED SINUOSITY VALUE:** Sinuosity is calculated for each reach using a 1:24,000 scale USGS topographic map. Divide the estimated value for mapped stream channel length discussed in the previous paragraph by the mapped valley length discussed in the above #7. Since a stream channel is at least as sinuous as its valley floor, the value derived must be equal to or greater than 1.0. Record the value to the nearest 0.01. (FL:4 (e.g., 99.99))

11. **MAPPED VALLEY WIDTH ESTIMATE:** Enter an estimate of the average valley floor width for the reach. The estimate is derived from interpreting 1:24,000 scale USGS topographic maps and aerial photographs of the valley. Valley floor width is the horizontal distance between the side slopes of the surrounding hills or mountains that confine the valley. The objective is an estimate within 10 percent of the actual average valley floor width for the reach. Elevation contour lines cross the line defining the stream. Use the midpoint along the stream between contour intersections to make your estimate of the valley width. Record the estimate to the nearest 10 ft. (FL:4 (e.g., 9990))

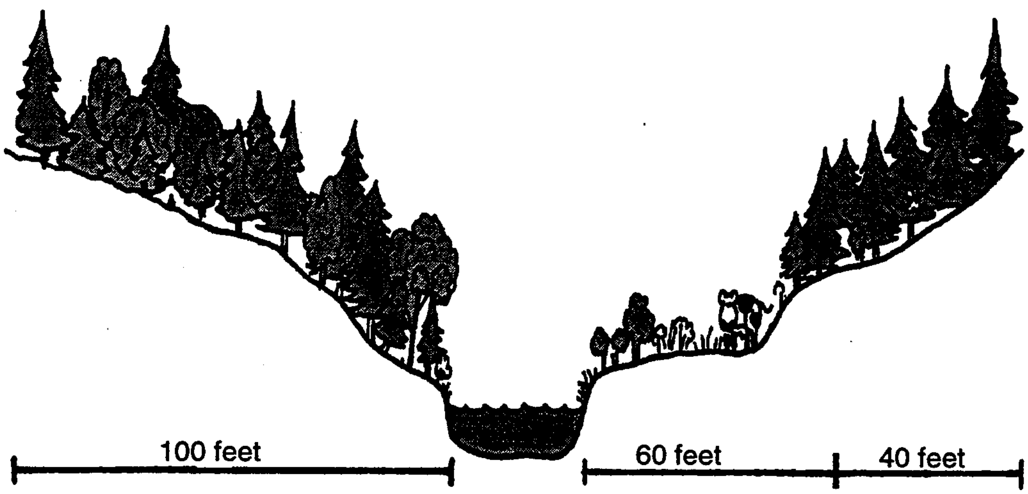
12. **ROSGEN STREAM TYPE:** Enter the Rosgen level I letter designator which best fits the conditions observed for the stream reach. The methodology is defined in *Applied River Morphology*, Rosgen, D., 1996. Copies of this beautifully illustrated text have been distributed to every National Forest in the Pacific Northwest Region. Consult your local hydrologist and/or fisheries biologist for further clarification.

13. INNER RIPARIAN ZONE WIDTH: The riparian zone investigated in this inventory is an area on either bank which is 100-feet wide. The inner riparian zone is the portion of that 100 feet which is characterized by a vegetative condition that is different from the remainder of the riparian zone. It is often the case that vegetation changes dramatically as the distance from the bankfull channel increases. True water-adapted plants may only occur very near the wetted channel. Alternatively, the inner riparian zone may describe an area in which ground-disturbing flows occur with sufficient frequency that mature conifers are quite rare, and a distinct hardwood zone is identifiable. The estimate of inner riparian zone width is the average width along both banks from bankfull to the distinct change in vegetation. The outer zone is calculated by subtracting the inner zone from 100 feet. For example, if the inner zone for the reach is estimated to be 60-feet wide, then the outer riparian is 40-feet wide (see figure 4). Forests have the option to designate a single riparian zone, and in such a case, enter 100 feet as the inner riparian zone width. (FL:3 (e.g., 100))

14. COMMENTS: Write down any comments important to the aquatic or riparian resources. This is a good place to clarify some of the entries made to Form B2. In particular, a description of the reasons for ending the reach should be included, as should a description of the location (NSO and Habitat Type Number) of any thermographs placed in the reach. Other comments may include left and right bank designations used for the survey; nearby landslides associated with the reach; road fords within the reach; an estimate of juvenile fish habitat availability; a list of amphibians or other wildlife observed in the reach; problems at culverts on tributaries to the reach; the general condition of the upland slopes; and how well shaded is the reach's wetted channel. (FL:240 (e.g., Broke reach at trib contributing 30% to flow = T13, near-riparian grazing widespread and shade provided by trees is spotty, 3 steelhead redds discovered on flanks of point bars))

15. VALLEY FORM [Forest Option]: Enter valley form code which best describes the average condition for the reach. The designations are based on valley floor width and the gradients of the valley sideslopes. See Appendix C for figure. (FL:2 (e.g., 10))

Figure 4: Examples to help you decide how to designate the inner riparian zone width



Example 1: no clear vegetation zones are apparent, so use one zone = 100 feet if the condition is the same on both bank's vegetation zones.

Example 2: designate an inner vegetation zone if you expect to encounter a change in vegetation due to elevation (e.g. terraces), altered habitat (roads), or other management activities (harvest, grazing).

Remember that during the survey, both sides of the stream will have the same inner vegetation zone width for the entire reach.

STREAM HABITAT DATA FORM B2
R6-2500/2600-21

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ____

F. Watershed Code ___, ___, ___, ___ NFS ___,___;___.___,___.___,___.___,___.___

G. USGS Quad ____

H. Survey Date ____-______-____

DD-MMM-YY

1. Observer/Recorder ________________ ________________	1. Observer/Recorder________________ ________________
2. Date ____-____-____	2. Date ____-____-____
3. Reach Number _____ RM _____ to _____	3. Reach Number__________RM _____ to _____
4. Natural Sequence Order (NSO) from_______to______	4. Natural Sequence Order (NSO) from_______to______
5. Flow ________________	5. Flow ________________
6. Mapped River Mile________________	6. Mapped River Mile ________________
7. Mapped Channel Length ______________	7 Mapped Channel Length______________
8. Mapped Valley Length______________	8. Mapped Valley Length ______________
9. Mapped Channel Gradient ____________	9. Mapped Channel Gradient____________
10. Mapped Sinuosity Value ____________	10. Mapped Sinuosity Value____________
11. Mapped Valley Width Estimate ________	11. Mapped Valley Width Estimate________
12. Rosgen Stream Type ____________	12. Rosgen Stream Type ____________
13. Inner Riparian Zone Width ____________	13. Inner Riparian Zone Width ____________
14. Comments ________________ ________________ ________________	14. Comments ________________ ________________ ________________
15. Valley Form ________________	15. Valley Form ________________

STREAM HABITAT DATA - FORM C, R6-2500/2600-22

The following items should be recorded on Form C for the habitats to be surveyed. Each Forest should establish a standard for "right bank" and "left bank" orientation (see figure 5 to clarify the importance of distinguishing the banks of the stream). This orientation shall remain consistent over the forest once established. NOTE: the USGS standard establishes orientation while looking downstream.

There are four potential estimated dimensional attributes. They are habitat length, average habitat width, maximum habitat depth, and maximum depth at pool tail crest. The first three attributes will be measured at every "nth" unit ("nth units" are also referred to as "measured units"); maximum depth at pool tail crest will be measured at every pool. The measured information will be placed in the data categories on Form C directly below each corresponding estimated value for that habitat unit. In addition, items 16-31 are to be entered on the same line (row) of Form C as the measured dimensions of the "nth" habitat units. Survey teams using the SDR software in a handheld data recorder must follow the procedures outlined in that software's manual. While the attributes collected are identical, measured habitat attributes are entered to SDR differently than is appropriate for the hardcopy field data forms.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM C HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS

FORM C INSTRUCTIONS

I. REACH NUMBER: Reaches shall be numbered sequentially, with the first reach beginning at the downstream startpoint of the survey, usually at the mouth of the stream, with each succeeding reach's startpoint coinciding exactly with the previous reach's endpoint (e.g., 1, 2, 3, etc.).

THE FINAL REACH BOUNDARIES MAY CHANGE FOLLOWING VERIFICATION DURING THE FIELD PHASE. PRIOR TO COMPUTER DATA ENTRY, FINAL DELINEATION MUST OCCUR, AND THE TRUE REACH NUMBER MUST BE ASSIGNED TO THE RESPECTIVE HABITAT UNITS.

When starting a new reach, record the data on a new Form C. This will facilitate data entry and minimize data entry errors.

MAKE SURE NSOs LISTED ON FORM B2 COINCIDE WITH THE NSOs ON ALL THE FORM Cs COMPLETED FOR EACH REACH BEFORE YOU BEGIN DATA ENTRY TO THE SMART DATABASE.

J. SAMPLING FREQUENCY: Enter the chosen frequency for sampling the "nth" or measured habitat unit. For example, if sampling pool and riffle habitat types at a 20% frequency, enter 1/5 (1/5 = 20/100 = 20%) for both habitat types.

The Sampling frequency must be sufficient to ensure at least 10 pools and 10 riffles AND 10 percent of all pools and all riffles are sampled as measured habitats for each observer on each stream.

On longer streams where the required numbers of measured units can be met, a minimum of 10 percent of pool and riffle units is recommended. Shorter streams may require a much greater sampling frequency to achieve the necessary number of measured units. If a certain habitat type is uncommon (i.e., pools under certain stream conditions), it is possible that 100 percent of those habitat units must be measured to achieve the minimum of "10 measured units" of both habitat types.

Refer to **#5** of the **"STANDARDS"** section in the beginning of this chapter for a discussion of how to randomly designate the first pool and first riffle to be treated as "nth" or measured habitats.

The asterisk (*) on Form C denotes the additional habitat attributes that require entries for measured units. **DO NOT** fill in these data categories in the rows for non-measured (estimated) habitat units.

1. NATURAL SEQUENCE ORDER (NSO): Enter a unique natural sequence order number for each habitat unit. NSOs should be entered in the same order as habitat units are encountered in the field survey, beginning with the first habitat unit and incrementing sequentially as new habitats are encountered moving upstream, (e.g., 1, 2, 3, etc.)

The numbering sequence shall remain consistent between reaches, (if Reach 1 ends at NSO #203, then Reach 2 shall begin at NSO #204). There are only two exceptions: a reach of private land to which access has not been granted, and a lake which occupies a middle segment of the surveyed stream channel (see figure 3). In either case, a reach number is assigned to the private land and to the lake; but no NSOs are assigned to either of those two reaches. Sequential assignment of NSOs resume in the <u>next</u> upstream reach (e.g., if Reach 2 is private land, no access, then NSOs are as follows: Reach 1 = NSO 1 to 203; Reach 2 has no NSOs assigned; Reach 3 = NSO 204 to 251...).

All side channels (S) and tributaries (T) with streamflow at the time of the survey should be treated as individual habitat units and assigned individual NSO numbers. They should be assigned the next incrementally higher NSO than the main channel habitat unit into which they flow. When multiple habitat units (tributaries and side channels) converge upon the mainstem habitat at exactly the same place, number them in a clock-wise order while facing upstream (see figure 5). (FL:4 (e.g., 9999))

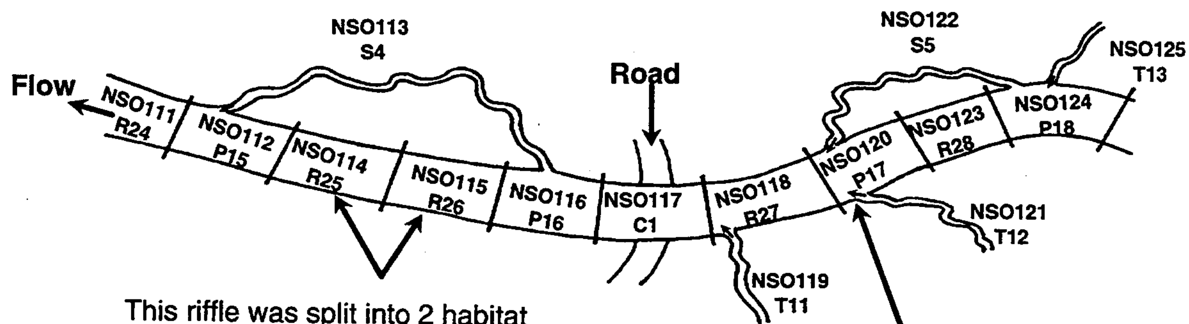
2. HABITAT TYPE AND NUMBER: Enter the habitat unit type and number for each unit. Valid habitat codes include:

P = Pool
R = Riffle
S = Side Channel
T = Tributary
D = Dry Main Channel
C = Culvert (Form C1)
F = Special Cases (chute, falls, dam, marshlands, braided channel (Form C2)

Habitat type numbers will be assigned sequentially as the inventory progresses upstream. Both NSOs and habitat numbers are lowest near the downstream end (= startpoint) of the inventory, regardless of habitat type. The reach number has no bearing on how numbers are assigned to habitats (e.g., if Reach 1 ends at P25, the next pool encountered would be in Reach 2, and it would be designated P26.)

In order to consider a habitat type as a separate unit, the habitat length must be equal to or greater than the wetted width. The <u>**ONLY**</u> exceptions to this rule are special case habitats and channel-spanning plunge pools (see figure 6).

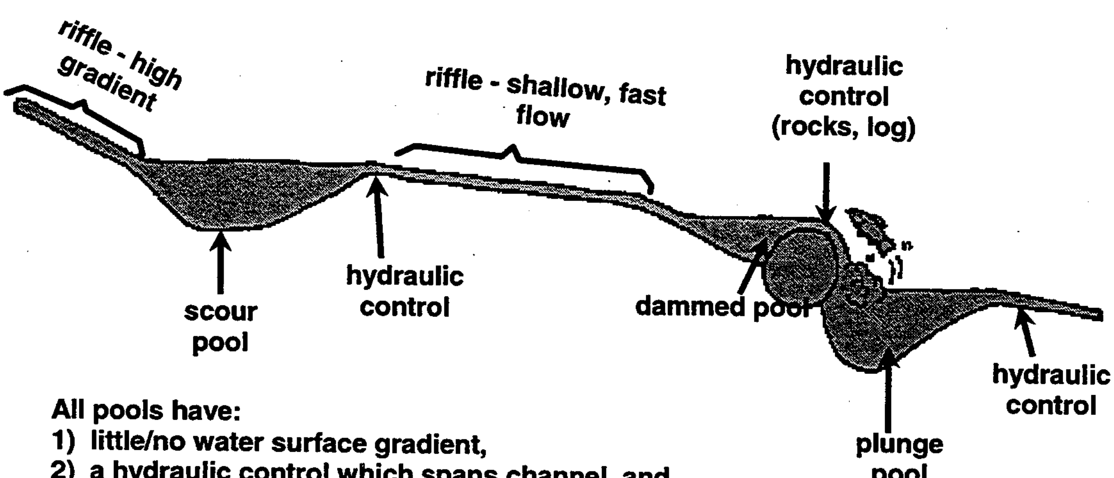
Figure 5: How to designate habitat unit NSOs for a stream with side channels and tributaries



This riffle was split into 2 habitat units because of difference in depth, gradient, etc. (Habitat units >999 feet must be split into smaller units.)

When two "habitats" flow into the same mainstem habitat at the same place (on opposite banks), assign NSO's in a clockwise fashion with the mainstem habitat upper unit boundary at 12 O'clock.

Figure 6: Basic characteristics of a pool/riffle system



All pools have:
1) **little/no water surface gradient,**
2) **a hydraulic control which spans channel, and**
3) **a residual pool depth.**

Plunge pools of this type typically are located downstream of a debris jam or log which spans the wetted channel. Such a condition causes a pool to be scoured during high flow events. These pools must span the width of the wetted channel, but they need not be longer than their average width.

For all habitats other than channel-spanning plunge pools and Special Case habitats, if the wetted length of a habitat unit (measured along the thalweg) is not greater than the average wetted width, do not consider it as a separate unit. For extremely long habitat units, (e.g., riffles approaching 900 feet in length) consider dividing them into smaller more manageable lengths. Splitting very long riffles into smaller, consecutive riffles is necessary because the SMART database has a habitat length limit of 999 feet. Use the endpoints of side channels attached to the riffle, changes in streambed composition, stream gradient in the riffle to divide a long riffle into shorter riffle habitats. Assign each of the sections of riffle a **different** NSO and habitat number (e.g., a survey team decides to split a 1245 ft. section of a stream into three consecutive riffles: a 455 ft. riffle (NSO 20, R10), a 530 ft. riffle (NSO 21, R11), and a 260 ft. riffle (NSO 22, R12)).

A measured habitat unit is **NOT** assigned its own NSO. Rather, the NSO assigned to the estimated habitat unit is shared by the measured habitat unit as well. Measured habitats are **NOT** unique habitats. Prefix each measured habitat unit with an "M" so that these are apparent during data entry. (Example: NSO 45, P23 = estimated habitat, NSO 45, MP23 = measured values for the same habitat). Only pool (P) and riffle (R) habitat types will have both estimated and measured attributes. The SMART database will treat dimensional attributes of length, width, and depth for all other habitat types as if the values are measured (i.e., they will have a correction factor of 1.0).

For side channels (S), enter only wetted length, average wetted width, and maximum depth. A side channel is separated from the mainstem channel by a stable island. The stability of an island in a forested stream is usually colonized by woody plants other than willow which are estimated to be at least 5-years old. In reaches characterized by meadows, a well-developed layer of soil atop the island indicates a stable secondary (side) channel. These stable secondary channels offer very important rearing habitat for juvenile salmonids. Do not assign an NSO to dry side channels. Do not break out individual habitat units (pools, riffles) within side channels. If a flowing side channel has a dry section, record the channel's total length as the sum of the dry and wet sections, and in "Comments" record the estimated length of dry side channel section. Also record in "Comments" both the bank of the mainstem channel into which the side channel flows, and the upstream mainstem habitat where the origin of the side channel is located.

Braided channels are considered to be Special Case habitats (an "F" habitat type). For a habitat to be considered a braided channel, there must be a minimum of three channels scoured during bankfull flows. Braided channels are characterized by unstable islands subject to movement during normal high flow events. These islands do not support woody plants other than willows, and they lack a developed soil layer. Herbaceous plants and willows can colonize on unstable islands, and as such are poor indicators of a channel's stability during normal high flow conditions. See the instructions in this chapter for **"Special Cases-Other-Form C2"** for a complete description of the five habitats considered Special Case Habitats.

For tributaries (T), enter the length, average width, and maximum depth of the first habitat unit of the tributary. Record the tributary's water temperature and the time it was taken.

Estimate a percent of flow contributed by the tributary to the mainstem streamflow below the tributary. In "Comments," record the estimated flow contribution as well as which bank the tributary intercepts. If possible, identify the tributary on the field map, and label with the appropriate NSO and tributary sequence number.

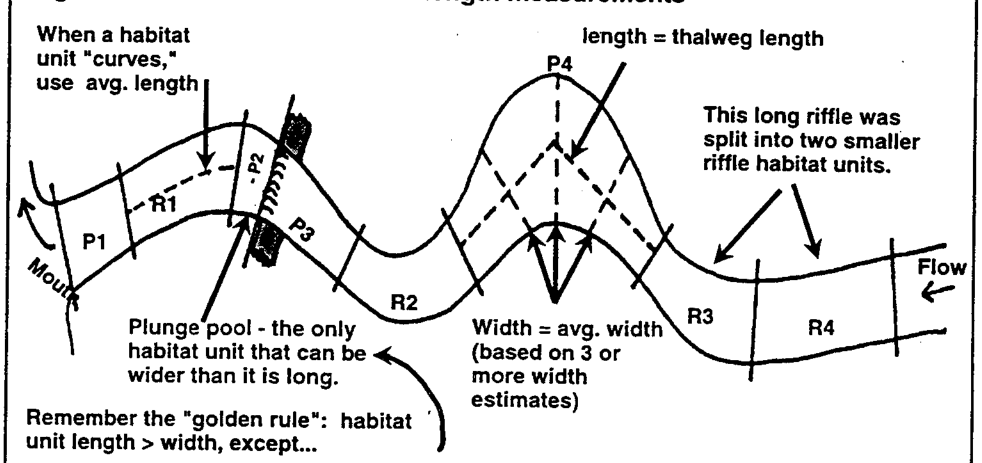
For dry main channels (D), enter only the length of the inventoried mainstem stream channel which is dry at the time of the survey. Enter 0 for wetted width. Large woody material within the bankfull channel of a dry channel segment is potentially mobile during high flow events. Any LWD within a dry main channel habitat should be tallied according to its dimensions and recorded in either the adjacent upstream or downstream pool or riffle. A "comment" should be made anytime wood recorded with the habitat is not located within that habitat.

Special Case habitats (falls, chutes, dams, marshlands, and braided channels) are assigned an NSO and their own "F" habitat sequence number. Culverts are given an NSO and flagged as "C" habitats; they are also sequentially numbered. Enter the appropriate NSO and habitat sequence type and number to Form C, but the remaining information is gathered on different forms; the Form C1 for culverts and Form C2 for the other special case habitats. Instructions for completing the appropriate forms are found in this chapter under the headings **"Special Cases - Culverts - Form C1" and "Special Cases - Other - Form C2."** (FL:5 e.g., MP999)

3. HABITAT LENGTH: Enter the wetted length for each habitat unit. This is visual estimate of the habitat length along the thalweg. The observer will estimate habitat length at each unit. Measured (or nth) habitat units are inventoried as if they are estimated habitats, and after the estimated attributes are recorded, only then can the recorder inform the observer that the habitat is a measured habitat. The team then measures the habitat's length along the thalweg, but only the recorder is permitted to know the actual measurement. The estimated and measured values for habitat length shall be reported to the nearest foot. (FL:3 (e.g., 999))

4. HABITAT WIDTH: Enter the visually estimated average wetted width for each habitat unit. The observer decides where to measure habitat width in the measured (nth) habitat units, but the measured value is known only by the recorder. Enter the estimated and measured values for habitat width to the nearest foot, or to within 10 percent of the actual average width, whichever is smaller (see figure 7). (FL:4 (e.g., 999.9))

Figure 7: Habitat unit width and length measurements



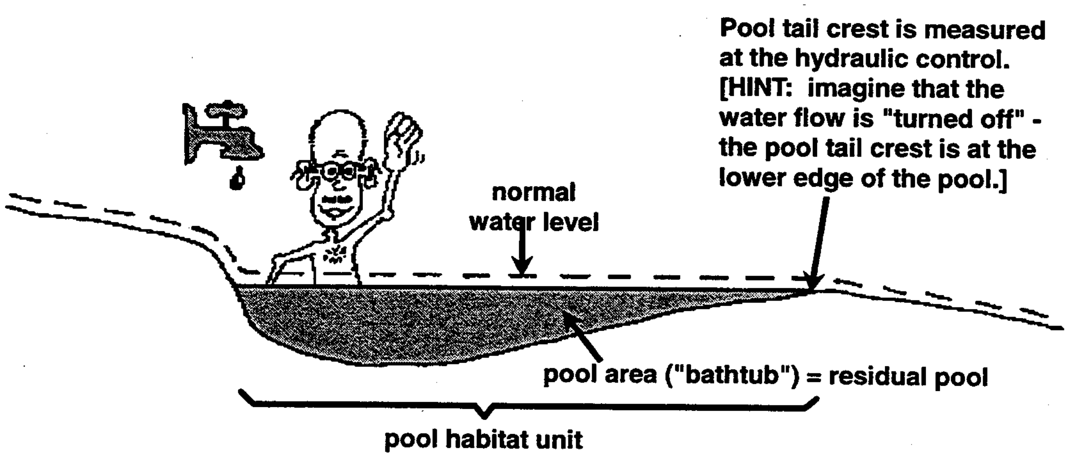
5. MAXIMUM DEPTH: Enter the measured maximum depth for each habitat to the nearest 0.1 ft. The maximum depth will be measured wherever that depth is less than 4 ft. In those habitats in which maximum depth exceeds 4 ft., an estimate of maximum depth will be made. Because the maximum depth is measured in every unit, enter this dimension as both "estimated" and "measured values" for maximum depth in measured (nth) habitat units. This will artificially generate a correction value of 1.0 for maximum depth in the SMART database. Maximum depth can be easily measured in most habitat units with a scale stick if the depth is less than 4 ft. (FL:3 (e.g., 99.9))

6. AVERAGE DEPTH [Forest Option]: Estimate the average depth in riffles only. This is an ocular estimate, and implementation is a Forest-level decision.

7. DEPTH AT POOL TAIL CREST: Enter the maximum measured depth to the nearest 0.1 ft. at the pool tail crest for every pool habitat unit. This location is at the point where the water surface slope breaks into the downstream riffle or plunges to a pool below the upstream pool. Measure the maximum depth at this point along the width of the hydraulic control feature that forms the pool. The hydraulic control can be viewed as a dam holding back the pool's water. This "dam" is rarely a straight line across the downstream end of the pool, rather it usually forms an irregular curve.

To identify the location of the maximum depth along the hydraulic control (pool tail crest), visualize a condition in which streamflow has almost stopped, but a trickle of water is still exiting the pool (see figure 8). That point is the maximum depth at the pool tail crest. This measurement is for calculating residual pool volume (e.g., maximum depth minus pool tail crest depth = maximum residual pool depth). The depth will be measured at each pool unit and estimated wherever the maximum depth at pool tail crest exceeds 4 ft. (FL:3 (e.g., 99.9))

Figure 8: How to visualize where the pool tail crest occurs



8, 9, 10, 11, 12. STREAMBED SUBSTRATE [Forest Option]: Enter the visually estimated percent that each size class of substrate comprises of the wetted streambed area. This estimate is made only after the observer has walked the length of the entire habitat. If any of the size classes of substrate listed below constitute at least 10 percent of the area of the streambed, record the percent in the appropriate column, in increments of 10 percent, each size class supplies to the surface of the streambed. Each Forest has the option to collect estimates of streambed substrate or to disregard these qualitative attributes.

Caution: There is a tendency for observers to over-estimate the percent of streambed which is cobble or greater in size. Surveyors under-estimate the contribution to area made by the edgewater streambed. The margins of most habitats tend to have a streambed comprised of smaller substrate than commonly found in deeper portions of the habitat.

Use the following size classes:

SA = Sand, Silt, and Clay	(<0.08 in....<2 mm.)	(smaller than "BB")
GR = Gravel	(0.08 - 2.5 in....2 - 64 mm.)	("BB" to tennis ball size)
CO = Cobble	(2.5 - 10 in....64 - 256 mm.)	(tennis ball size to basketball size)
BO = Boulder	(10.0 - 160 in....256 - 4096 mm.)	(basketball to small car)
BR = Bedrock	(>160 in...>4096 mm.)	(larger than a small car)

(FL:3 (e.g., 100))

13, 14, 15. PIECES OF LWD: Enter the number of pieces of large woody debris (LWD) within the bankfull channel for each habitat unit. The presence of LWD in the bankfull channel decreases the force of high flow events, tends to capture substrate, offers cover for fish and refuge from the force of storm events. Large woody debris also slows the movement of organic matter (leaves, twigs, and drifting macroinvertebrates) allowing aquatic organisms to more efficiently process and retain the nutrients available in organic debris.

To be included, the tree bole or root swell of live or dead trees must interact with the streamflow at bankfull conditions. The bole of a tree is the trunk of a tree, and is known by its gentle taper from the bottom to the top of the tree. The root swell is the portion of the tree between the roots and the bole; root swell is the fusion of individual roots, creating a sharply tapered portion of the tree. The stump of a tree is largely root swell. The roots are the subterranean branched network of a tree.

If a log or tree leans over the bankfull channel or spans the wetted channel, but does not interact with the streamflow during bankfull conditions, do **NOT** count it as LWD (see figure 9). Leaning trees (i.e., potential LWD) are **NOT** included in the LWD entered to the SMART database. The approximate numbers of potential LWD (i.e., leaning trees or channel-spanning logs above bankfull flow) are appropriately recorded in “Comments” only.

If only the roots of a tree intercept bankfull flow, the tree is not counted as LWD. Enter the number of pieces of large woody debris in each of the three size classes; Small, Medium, and Large. Use the following minimum diameter and length criteria:

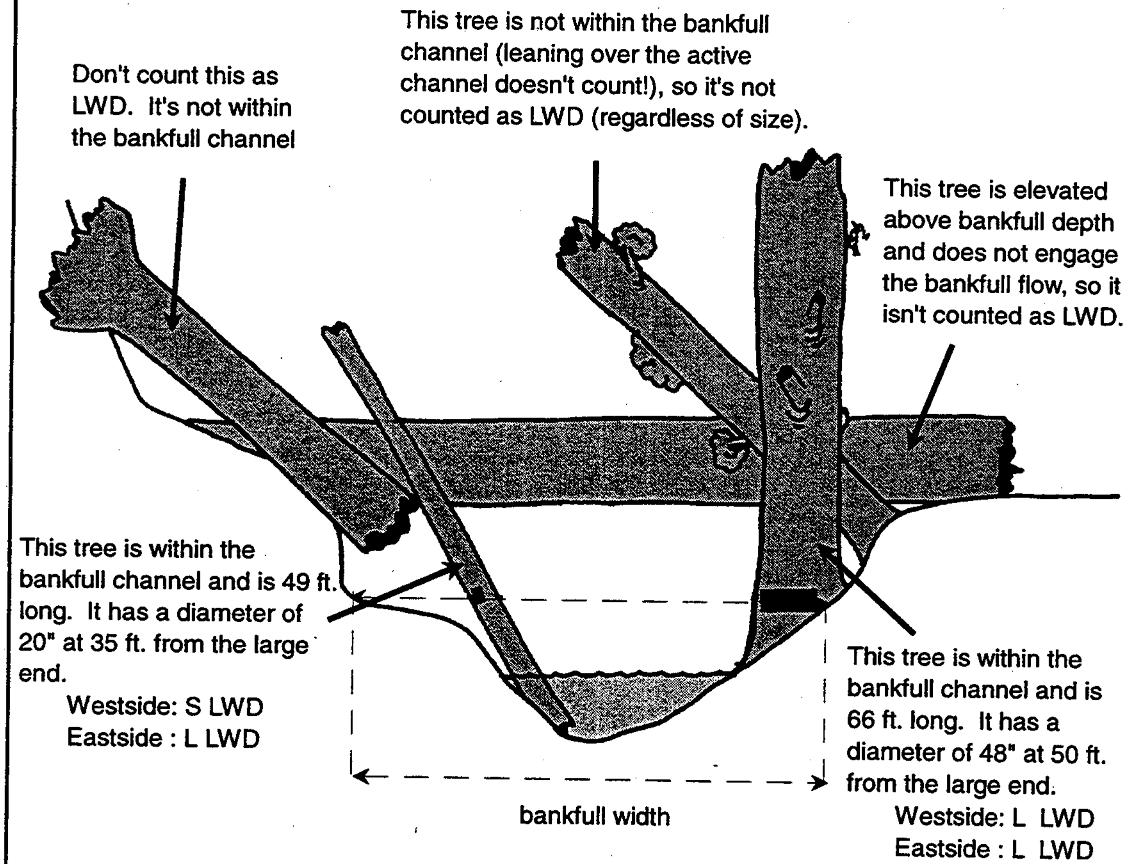
Eastside Forests (east of the High Cascades):

(13) S = Diameter > 6 in, at a length of 20 ft. from the large end (Forest option)
(14) M = Diameter > 12 in, at a length of 35 ft. from the large end (Mandatory)
(15) L = Diameter > 20 in, at a length of 35 ft. from the large end (Mandatory)

Westside Forests (west of the High Cascades):

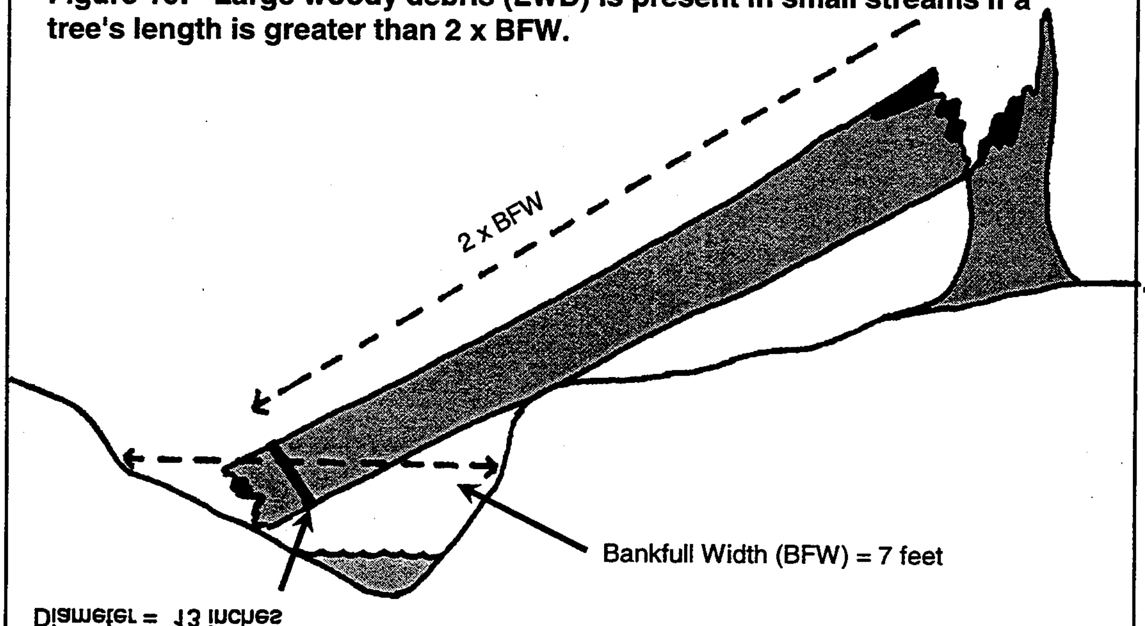
(13) S = Diameter > 12 in, at a length of 25 ft. from the large end (Forest option)
(14) M = Diameter > 24 in, at a length of 50 ft. from the large end (Mandatory)
(15) L = Diameter > 36 in, at a length of 50 ft. from the large end (Mandatory)

Figure 9: Classifying a tree as large woody debris (LWD) is dependent on whether or not the tree is at least partly within the bankfull channel.



If a piece of large wood does not meet the length criteria listed on the previous page, but is longer than twice the average bankfull width for the reach, count the piece in the appropriate size class. Measure the minimum diameter at a distance from the large end equal to twice the average bankfull width for that habitat unit. The diameter size criteria do not change regardless of the length of the piece of large wood (see figure 10).

Figure 10: Large woody debris (LWD) is present in small streams if a tree's length is greater than 2 x BFW.



This tree is 15 ft. long, which doesn't meet the normal minimum length criteria for LWD. But, because it is at least twice as long as the BFW, it is counted as LWD. The size class of LWD is based on the diameter of 13 inches at a distance from the large end equal to twice the BFW of the habitat unit.

For this example:
Eastside: M LWD
Westside: S LWD

Make note of logjams, and rootwads in the bankfull channel under "Comments." It is important to remember that LWD encountered in a habitat type treated as a Special Case habitat will not be recorded in the SMART database if entered ONLY in the "Comments" section of Form C2. Therefore, those pieces must be recorded with the normal habitat (e.g., pool or riffle) immediately upstream or downstream. Should such a condition occur, make a clarifying note in the "Comments" that the surveyors have added the LWD of the Special Case habitat to the wood count for the pool or riffle adjacent to the Special Case habitat. (FL:2 (e.g., 99))

The following instructions (16 through 31) refer to measured (nth) habitat attributes ONLY.

16. BANKFULL WIDTH (BFW): Enter the MEASURED bankfull width at each measured (nth) riffle. Bankfull is defined as the high streamflow event occurring on average every 1.5 years. This streamflow forms and maintains the channel over time. Select sections of riffles that have a straight and relatively narrow channel since such sites offer the clearest bankfull indicators. The banks along the site selected for measuring BFW must be free of obstructions which cause high flow backwater across the entire channel. An area with an undercut bank is also a very poor choice for bankfull determination since bank slumping will give a false reading of bankfull conditions. An actively eroding bank is another unreliable site for measuring bankfull flow.

Bankfull is identified by interpreting the evidence of bankfull flow atop the banks of the stream. The most consistent indicators of bankfull flow are the areas of deposition; the top of these deposits define the active floodplain. These deposits are often known by the change in particle size. Other indications of bankfull flow are less reliable. But by using all of the evidence, accurate bankfull measurements can be obtained. The other bankfull indicators include: a change in vegetation (i.e., from none to some, or from herbaceous to woody); a change in bank topography (a change in slope of the bank above the water's edge); a line defining the lower limit of lichen colonization; a stain line visible on bare substrate; a defined scour line (exposed roots, etc.); a line of organic debris on the ground (but NOT debris hanging in vegetation!).

Stretch a measuring tape taut, level, and perpendicular to the thalweg across the channel at the elevation of the clear bankfull indicators. Enter the measurement of BFW to the nearest 0.1 ft. (FL: 4 (e.g., 999))

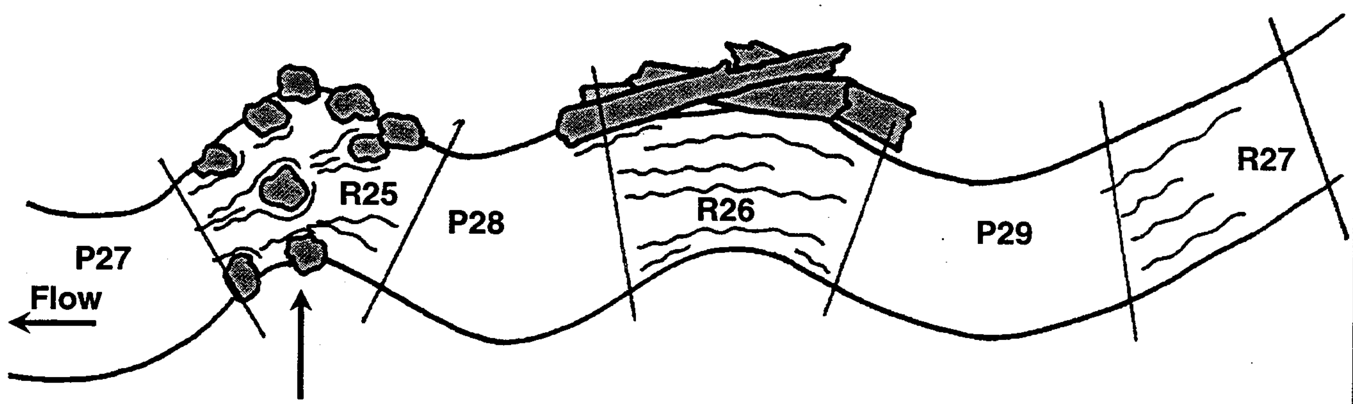
If clear indicators of bankfull flow are absent in the measured riffle, no bankfull or floodprone measurements should be taken. However, the remaining measured attributes should still be determined for the measured riffle before proceeding to the next upstream habitat. The surveyors must then investigate each succeeding riffle for clear indicators of bankfull flow. Once bankfull indicators are discovered, the surveyors will make the bankfull and floodprone determinations at that riffle, but the measurements will be recorded with the **ORIGINAL MEASURED RIFFLE.** A "comment" should be made with the measured riffle that identifies which riffle was used for the bankfull and floodprone determinations.

For example, assume the survey team is sampling every sixth riffle as a measured (nth) riffle, and R23 is the next designated measured riffle. However, R23 occurs on a channel bend, and the team determines there is no appropriate place along R23 to identify bankfull conditions. Therefore, the next riffle, R24, is carefully investigated for bankfull indicators. Assuming clear indicators are present, an appropriate site is chosen along R24 for bankfull measurements. The next measured riffle remains R29 (23 plus 6) and the sampling scheme for measured riffles is unchanged: R23, R29, R35, etc. See figure

11 for a different example.

Figure 11: An example showing what to do if a "measured riffle" does not have any clear indicators of bankfull width

Assume you randomly selected R5 as your first measured riffle and you are using a 1:5 (i.e., 20%) frequency. This established the sequence of R5, R10, R15, R20, R25, etc., as measured riffles.



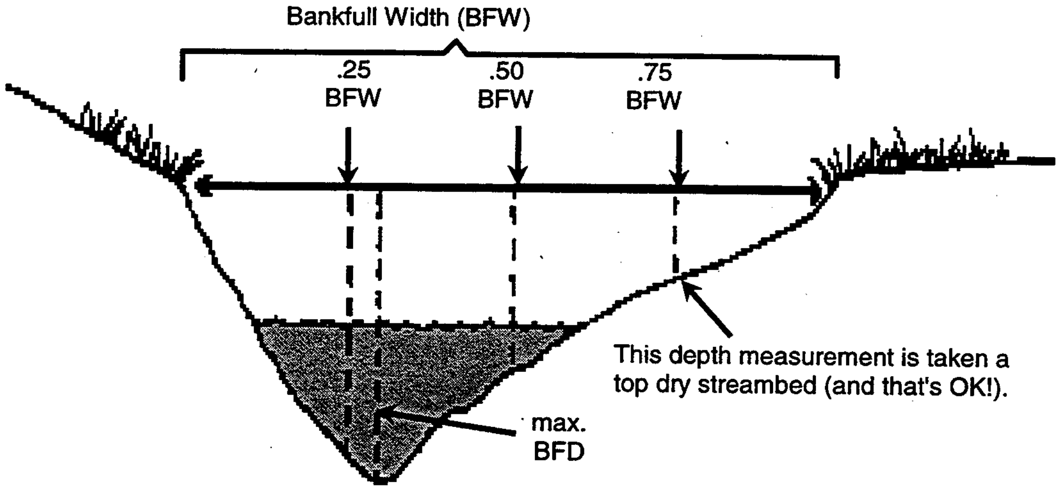
Oh, oh - R25 is the" Nth" riffle where you're supposed to measure bankfull. But you discover there are no clearly visible bankfull indicators. When that happens, measure the average wetted width, measure any unstable banks, and record the temperature/time in R25. But you must search for clear bankfull indicators in the next riffle.

In this example, R26 also lacks clear bankfull indicators because of a debris jam on the left bank. So you continue to the next riffle, where you find clearly visible bankfull indicators. Therefore, bankfull and floodprone measurements are taken in R27. However, these measurements are recorded with the original measured riffle, R25. That is, there is no need to change the sequence of measured riffles! Simply record all measured attributes with the original measured riffle regardless of where the bankfull and floodprone determinations are made.

17, 18, 19. BANKFULL DEPTH: At each measured (nth) riffle, measure the bankfull depth at 25 percent of BFW, 50 percent of BFW, and 75 percent of BFW. This is the measured height from the streambed to the measuring tape stretched taut and level across the channel at a height equal to bankfull flow. These measurements will be made at the same location as the site for bankfull width (BFW). Record each bankfull depth (BFD) measurement to the nearest 0.1 ft.

It is expected that some of these measurements will be made outside of the wetted channel atop dry streambed since the surveys are performed under low streamflow conditions. See figure 12 for a visual depiction of the process. (FL:3 (e.g., 99.9))

Figure 12: Where to measure bankfull depths (BFD) in order to determine the average BFD and maximum BFD



Average BFD = depth @ (.25 BFW + .50 BFW + .75 BFW)/3
Maximum BFD = maximum depth measured along the same measuring tape used for BFW and average BFD.

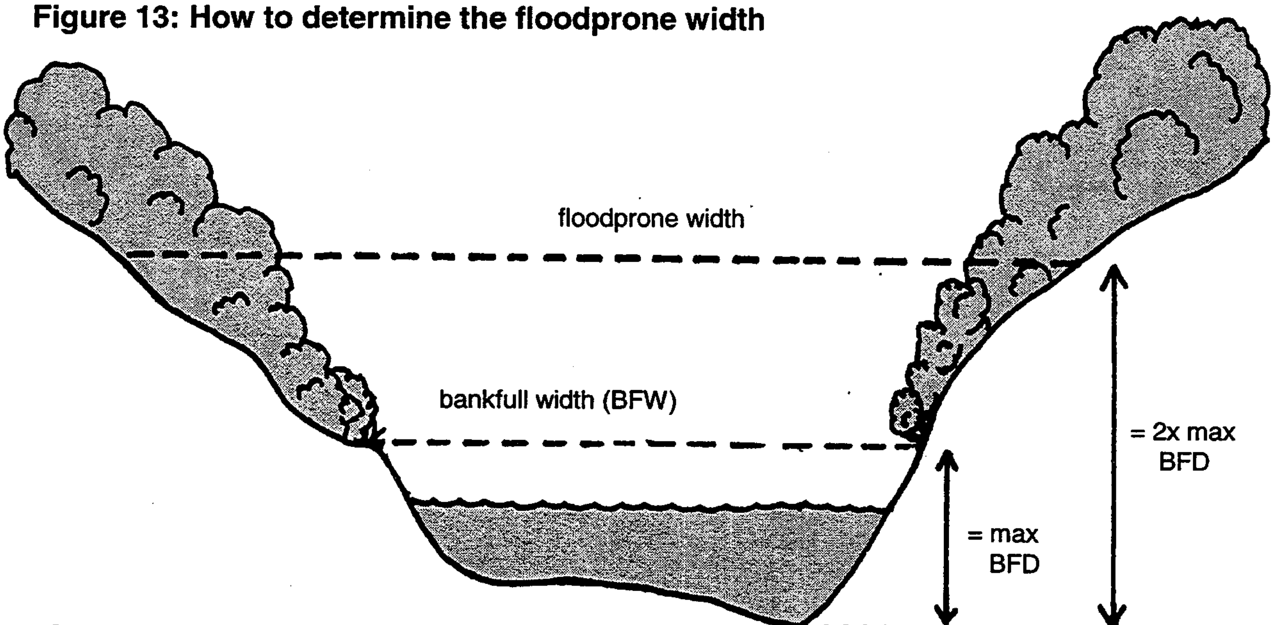
20. MAXIMUM BANKFULL DEPTH (max BFD): At the same time average bankfull depth is determined, measure and record the maximum bankfull depth along the stretched tape. This will inevitably be found along the thalweg in the wetted channel. It is simply the maximum elevation measured between the tape measure and the streambed. Record the measured value to the nearest 0.1 ft (see figure 12). (FL:3 (e.g., 99.9))

21. FLOODPRONE DEPTH: The floodprone depth is determined by doubling the maximum bankfull depth (max BFD). The floodprone depth is the maximum depth in the channel during a flood which occurs approximately every 50 years. Record twice the max BFD as the floodprone depth, to the nearest 0.1 ft (see figure 13). (FL:3 (e.g., 99.9))

22. FLOODPRONE WIDTH: The floodprone width is determined by extending the floodprone elevation across the valley floor (see figure 13). The floodprone width is the width of the valley floor inundated during a flood which occurs approximately every 50 years. To determine floodprone width, pieces of flagging could be temporarily tied to vegetation atop both sides of the channel, at a height equal to the floodprone depth. A measuring tape could then be stretched level, at the same elevation as the flagging elevation, across the valley floor until the tape touches the ground on either side of the stream.

If the floodprone width is less than 2.5 times the bankfull width at that location, measure to the nearest foot. If the floodprone width is greater than 2.5 times the bankfull width at that location, simply estimate the floodprone width. The ratio of floodprone width to bankfull width is referred to as the entrenchment ratio, and this ratio is useful in refining the level I Rosgen Stream Type for each reach. The maximum allowable floodprone width is 999 feet. (FL:3 (e.g., 999)

Figure 13: How to determine the floodprone width



Steps to determine floodprone width:

1) Measure max bankfull depth (BFD) (on the bankfull transect).
2) Determine floodprone depth = 2 x max BFD.
3) Stretch tape across stream at height of floodprone depth, (Keep that tape level!) and measure distance between floodprone streambanks = floodprone width.

[Note: entrenchment ratio = (floodprone width)/(bankfull width)]

23, 24, 25. RIPARIAN VEGETATION (INNER ZONE): The width of the inner riparian zone is variable by reach and specified on Form B2. Once a width for the zones has been established, that distance must be maintained throughout the reach. Aerial photographs are usually sufficient to establish the average inner riparian zone width for each reach identified during the level I (office phase) inventory. A level II inventory seeks to characterize the average condition of the riparian vegetation for each reach. It is from the description of each measured (nth) habitat's vegetative condition that the average for the reach is determined.

It is a "Forest Option" to designate either a single 100-ft. wide riparian zone or two adjacent riparian zones (inner and outer zones) totaling 100 ft. in width. If a Forest chooses to characterize a single riparian zone, the data is entered to the columns labeled "Riparian Vegetation (Inner Zone)," and the remaining columns for vegetation labeled "Riparian Vegetation (Outer Zone)" are left blank.

23. CLASS: Enter the existing riparian vegetation successional class within the inner zone of each measured (nth) habitat unit. Use the following diameter codes to describe the riparian successional class (see Appendix D for illustration and definitions of successional stages). It is rare for riparian forests to consist of a single successional (i.e., seral) class. The task is to define from an overhead (i.e., bird's-eye) view which successional class occupies the most overstory area within the inner zone width along both banks of the measured habitat. It is the average of both banks' condition.

DIAMETER CLASS

NV = No Vegetation (bare rock/soil, dbh NA)
GF = Grassland/Forb Condition (dbh NA)
SS = Shrub/Seedling Condition (1.0 - 4.9 in. dbh)
SP = Sapling/Pole Condition (5.0 - 8.9 in. dbh)
ST = Small Trees Condition (9.0 - 20.9 in. dbh)
LT = Large Trees Condition (21 - 31.9 in. dbh)
MT = Mature Trees Condition ($\geq$ 32 in. dbh)

If no overstory layer is present and the dominant vegetation in the inner zone is in seral class GF, enter GF for (seral) Class. If the dominant vegetation in the inner zone is in seral class SS, enter SS for (seral) Class. (FL:2 (e.g., SP))

24. OVERSTORY: Enter the dominant overstory species of vegetation growing in the inner zone for each measured (nth) habitat unit, using the species codes listed below. Again, the task is to define from an overhead (i.e., bird's-eye) view which species occupies the most overstory area within the inner zone along both banks of the measured habitat. It is the average of both banks' condition.

If the seral class in the inner riparian is SP, ST, LT, or MT, use the following codes to identify the dominant overstory species. Forests may add to this list to include additional vegetation species. At a minimum, HX and CX can be used to denote hardwoods and conifers respectively. (FL:3 (e.g., HA)

Hardwood:
HA = Alder

HB = Bigleaf maple
HC = Cottonwood, ash, poplar
HD = Dogwood
HE = Elderberry
HL = Liveoak, canyon
HM = Madrone
HO = Oak, Oregon white, California black
HQ = Quaking aspen
HT = Tanoak
HV = Vine Maple
HW = Willow
HX = Other/unknown

Conifer:
CA = Subalpine fir, mountain hemlock, whitebark pine
CC = Cedar, western red
CD = Douglas-fir
CE = Subalpine fir - Engelmann spruce
CF = Fir, silver and noble
CH = Hemlock, western
CJ = Juniper
CL = Lodgepole pine, shore pine
CM = Mountain Hemlock
CP = Ponderosa pine, Jeffrey Pine
CQ = Western white pine
CR = Red fir
CS = Spruce, sitka
CT = Port-Orford-cedar
CW = White fir, grand fir
CY = Yew
CX = Other/Unknown

If there is no clear dominant species of tree in the overstory layer, then enter one of these three conditions as dominant: shrub/seedling, grass/forb, or no vegetation.

SHRUB SEEDLING HEIGHT [Forest Option]: Wherever shrub seedling is the dominant successional vegetative class, Forests have the option of designating the height class of the shrub seedling class wherever no dominant overstory species is present. For example, if shrubs between 5 and 10 feet tall are the dominant successional class in the inner zone, the entry for dominant overstory species would be SS3 (see Eastside example below). Shrub height classification is an optional field and applies only to seral class SS. Use the following categories:

1 = 0 ft. - 2 ft.
2 = 2 ft. - 5 ft.
3 = 5 ft. - 10 ft.
4 = > 10 ft.
((FL:3 (e.g., SS4))

25. UNDERSTORY: Enter the dominant understory species growing in the inner riparian zone for each measured (nth) habitat unit, using the species codes listed below. Each Forest must decide what defines the understory, and how to estimate conditions in this riparian vegetative layer. Contrasting views of understory include what species are likely to replace the canopy dominants with time and presently are sapling/pole versus what is the vegetative site potential where the understory is likely to be small shrubs.

Examples:

The examples depend on how Forests interpret the understory component of riparian vegetation.

Eastside - If seral stage in the inner zone is Grassland/Forb, with grasses dominant with a few shrubs 3 ft. tall: the entries for Class/Overstory/ Understory might be GF/SS2/GF. If seral stage is shrub/seedling dominant, with shrub/seedlings 30 ft. tall and alder subdominant the riparian vegetation might be categorized as SS/SS4/HA.

__Westside__ - Seral stage is large trees with Douglas-fir dominant in the overstory and western hemlock dominant in the understory, the designation for riparian condition might be LT/CD/HA.

26, 27, 28. RIPARIAN VEGETATION (Outer Zone)

26. CLASS: Enter the existing riparian vegetation successional (i.e., seral) class within the outer zone of each measured (nth) habitat unit. Use the diameter codes described in #23 (see Appendix D for an illustration and definitions of successional stages). The task remains the same as described for the inner riparian zone. Define from an overhead (i.e., bird's-eye) view which seral class occupies the most overstory area within the outer zone width along both banks of the measured habitat. It is the average of both banks' condition. Whenever a Forest chooses to characterize single riparian zone, it is considered an inner zone of 100 ft. In such a case, there is nothing recorded for the "Riparian Vegetation (Outer Zone)". (FL:2 (E.G., SP))

27. OVERSTORY: Enter the dominant overstory species of vegetation growing in the outer riparian zone for each measured (nth) habitat unit, using the species codes listed for #24 and #25. Again, the task is to define from an overhead (i.e., bird's-eye) view which species occupies the most overstory area within the outer riparian zone along both banks of the measured habitat. It is the average of both banks' condition. Forests again have the option to designate the height class of shrub/seedling wherever that seral class is the dominant overstory component (see #24 for an explanation). (FL:3 (e.g., CC))

28. UNDERSTORY: Enter the dominant understory species growing in the outer riparian zone for each measured (nth) habitat unit. Use the species codes listed for #24 and #25. It is the task of individual Forests to define the characteristics of the understory of interest to them. (FL:3 (e.g., SS2))

29, 30. WATER TEMPERATURE:

29. DEGREE: Take stream temperatures within the main stream channel at every measured unit. Enter to the nearest Fahrenheit degree. Submerge the thermometer for at least 1 minute to allow a handheld thermometer to adjust to the water temperature.

NOTE: Temperatures should be recorded for ALL measured units.

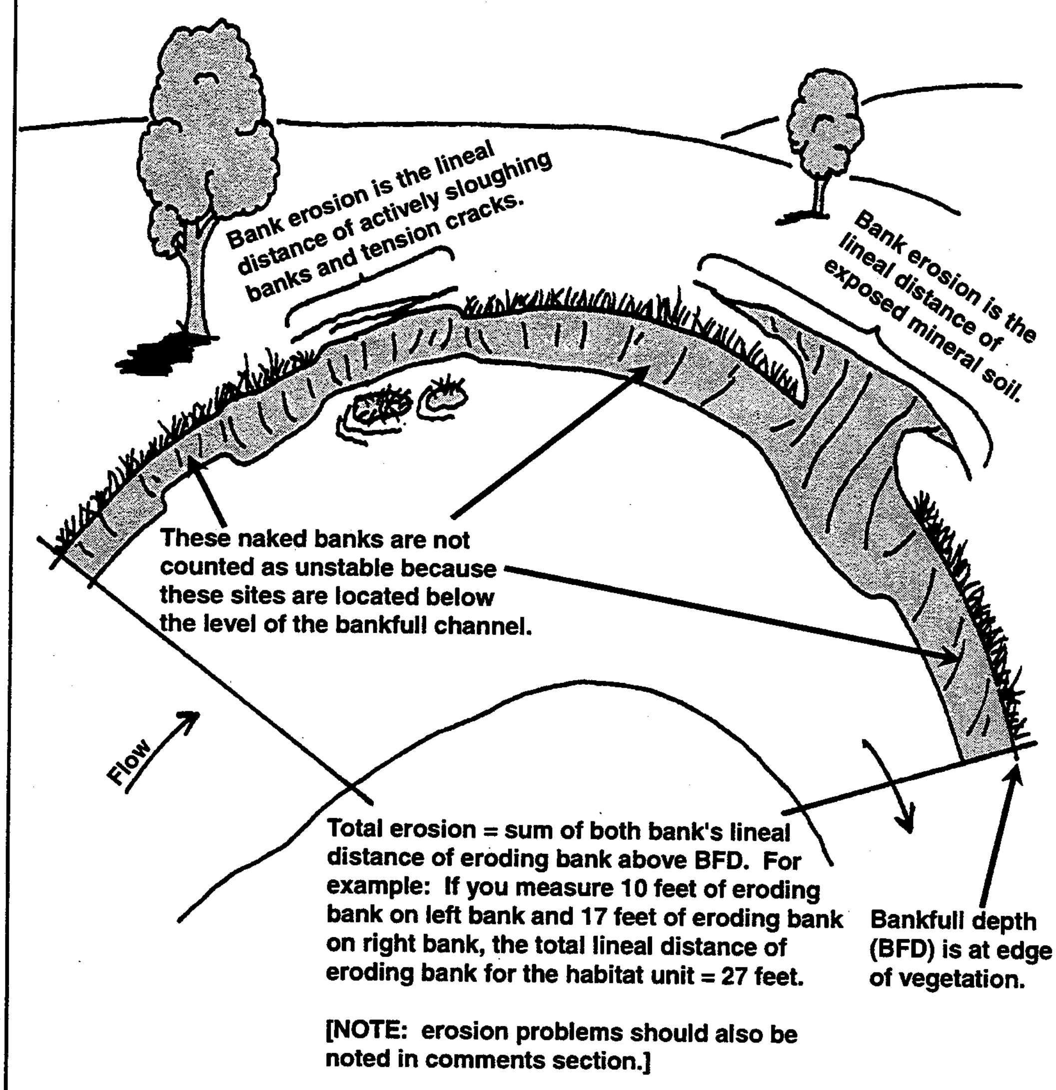
Stream temperatures should also be recorded for each tributary unit which is assigned an NSO. (FL:2(e.g., 68))

30. TIME: Enter the military time when temperatures are taken, and record the time to the nearest hour. (FL:4 (e.g., 1400))

It bears repeating for emphasis that every stream to be surveyed shall have a long-term thermograph installed in a pool near the startpoint of the inventoried stream that will record water temperatures from mid-June through late-September.

31. BANK STABILITY: Measure and sum the lineal distance of actively eroding banks along both sides of every measured (nth) habitat unit. Bank stability is a measure of actively eroding banks at an elevation above the bankfull stream margin. That is, naked substrate within the bankfull channel is normal condition due to the dynamic nature of the bankfull channel, and is not necessarily an indication of eroding banks. An eroding bank is characterized by any one, or a combination of the following factors provided they occur at an elevation above the bankfull flow: bare exposed colluvial or alluvial substrates, exposed mineral soil, evidence of tension cracks, or active sloughing (see figure 14). Record to the nearest foot. (FL:3 (e.g., 999))

Figure 14: Bank stability is the sum of the lineal distance of actively eroding banks on both sides of each measured habitat unit.



32-36. OPTIONAL FIELDS [Forest Option]: Place any additional information collected at habitat units in these columns. Forests may need to set up a separate data table in Oracle or other database to analyze this information.

STREAM HABITAT DATA FORM C
R6-2500/2600-22

Page: ___ of ___

A. State __________ B. County __________ C. Forest __________ D. District __________ E. Stream Name ______________________________

F. Watershed Code ___, ___, ___, ___ NFS ___, ___; ___.___, ___.___, ___.___, ___.___ G. USGS Quad ______________________________

H. Survey Date ___-_____-___ I. Reach Number ___________ J. Sampling Frequency ______________

DD-MMM-YY

Nat. Seq. Ord. (NSO)	Hab. Type & Num.	Hab. Len.	Hab. Wid.	Max. Dep.	Ave. Dep. (Forest Option)	Dep. at Pool Crest	Streambed Substrate (Forest Option)					Pieces of LWD			* Bankfull Width (BFW)	* Bankfull Depth			*Max. Bank full Depth (max BFD)	* Flood prone Depth	* Flood prone Width	* Riparian Vegetation (Inner Zone)			* Riparian Vegetation (Outer Zone)			* H_2O Temp		* Bank Stability	Optional Fields (Forest Option)				
							S A	G R	C O	B O	B R	S	M	L		1/4	½	3/4				Class	Over story	Under story	Class	Over story	Under story	Degree	Time						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

SPECIAL CASES - CULVERTS - FORM C1, R6-2500/2600-23

This form is intended to document specific information on road crossings encountered during the survey. Culverts are also to be noted on the general Form C as a "C" habitat type.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM C1 HEADER (ATTRIBUTES A - H) ARE LISTED IN THE FORM A INSTRUCTIONS.

1. **REACH NUMBER**: Enter the reach in which the culvert is located. (FL:3 (e.g., 999))

2. **NSO NUMBER**: Enter the NSO number assigned to the culvert and entered on Form C. (FL:4 (e.g., 9999))

3. **CULVERT NUMBER**: Enter the number of the culvert. Like other habitats of an inventoried stream, they are sequentially numbered from downstream to upstream, with every culvert assigned a "C" as the prefix to the culvert number. (FL:4 (e.g., C999))

4. **TYPE OF STRUCTURE**: Indicate the type of culvert by circling the appropriate cross-sectional sketch. (FL:10 (e.g., open arch))

5. **LENGTH OF STRUCTURE**: Enter the length of the culvert measured along the bottom of the culvert from the outlet to the inlet. Record to the nearest 0.1 ft. (FL:5 (e.g., 999.9))

6. **DIAMETER OR WIDTH**: Enter the measured diameter or width of the structure. If an arch, open arch, box, or open box, measure maximum width. (FL:4 (e.g., 999.9))

7. **CULVERT GRADIENT**: Enter the measured gradient as a percent slope using a hand level, abney level, or peep site. Measurement of slope using a clinometer is not acceptable. (FL:3 (e.g., 999))

8. **BAFFLES PRESENT**: Record Y for Yes, N for No to indicate the presence or absence of baffles in the culvert. (FL:1 (e.g., N))

9. **JUMPING DISTANCE HEIGHT**: Enter the measured height from the surface of the stream to the culvert's lip at the downstream end of the culvert. (Fl:2 (e.g., 99))

10. **POOL PRESENT**: Indicate whether a pool is present below the outlet of the culvert. Such a pool need not span the width of the wetted channel. (FL:1 (e.g., Y))

11. **POOL DIMENSIONS**: Enter the estimated average length, average width, and maximum depth of the pool, if present, adjacent to and downstream of the culvert's outlet. Record all dimensions to the nearest foot. (Length/FL:3 (e.g., 999); Width/FL:2 (e.g., 99); Depth/FL:2 (e.g., 99))

12. **WIDTH OF STREAM ABOVE CULVERT**: Measure and record the average wetted width of first habitat unit above the structure. Record to the nearest foot. (FL:2 (e.g., 99))

13. **OBSERVER/RECORDER:** Enter the observer and recorder's names as initial of first name and surname (e.g., J.Cool).

STREAM HABITAT DATA FORM C1
(CULVERTS)
R6-2500/2600-23

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________
E. Stream Name ____________________
F. Watershed Code ___, ___, ___, ___ NFS ___,____;____.____,____.____,____.____,____.____
G. USGS Quad ____________________
H. Survey Date ____-______-____
DD-MMM-YY

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Culvert # _______
4. Type of Structure (circle)
Round Pipe Box Arch Open Arch Open Box Elliptical

5. Length of Structure ______________ (ft) 6. Diameter or Width ____________ (ft)
7. Gradient ______________________ 8. Baffles Present _______________
9. Jumping Distance Height __________ 10. Pool Present _________________
11. Pool Dimensions L_____W_____D_____
12. Width of Stream above Culvert ______________________________
13. Observer/Recorder ____________________

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Culvert # _______
4. Type of Structure (circle)
Round Pipe Box Arch Open Arch Open Box Elliptical

5. Length of Structure ______________ (ft) 6. Diameter or Width ____________ (ft)
7. Gradient ______________________ 8. Baffles Present _______________
9. Jumping Distance Height __________ 10. Pool Present _________________
11. Pool Dimensions L ____W_____D_____
12. Width of Stream above Culvert ____________________________
13. Observer/Recorder ____________________

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Culvert # _______
4. Type of Structure (circle)
Round Pipe Box Arch Open Arch Open Box Elliptical

5. Length of Structure ______________ (ft) 6. Diameter or Width ____________ (ft)
7. Gradient ______________________ 8. Baffles Present _______________
9. Jumping Distance Height __________ 10. Pool Present _________________
11. Pool Dimensions L_____W_____D_____
12. Width of Stream above Structure ____________________________
13. Observer/Recorder ____________________

SPECIAL CASES - OTHER - FORM C2, R6-2500/2600-24

This form is intended to document specific information on falls, chutes, dams, marshlands, and braided channels encountered during the inventory. These are aquatic habitats that do not fit the standard habitat types entered on Form C.

Definitions:

FALLS: An essentially vertical drop in the channel bed that results in a waterfall. This is considered a fast water unit. It is a Forest-level decision as to what height of the drop constitutes a Special Cases habitat.

CHUTES: A section of the channel, usually constrained by bedrock, that results in a funnelling of streamflow through a narrow constriction. This is considered a fast water unit.

DAMS: Specific human-made structures to impound water.

MARSHES: A water-saturated, poorly drained wetland area either permanently or periodically inundated with water. It has no discernable bankfull channel.

BRAIDS: A series of three or more roughly parallel channels structured during bankfull flow and separated from each other by unstable islands. Vegetation on these unstable islands is typically either non-woody annual plants, very young seedlings, or willow. Bankfull flow will frequently cut new braids across these unstable islands. These secondary channels offer very poor winter refuge for juvenile salmonids, yet may offer high quality spawning opportunities for large adults. It is conceivable that during low flow, a single channel may be wet while the additional braids are dry.

Please see the discussion in Chapter 3 Stream Habitat Data Form C, number 15 concerning LWD encountered in Special Cases habitat. Large wood that engages bankfull flow within a special case habitat is viable LWD. However, it must be recorded with the pool or riffle nearest to the special case habitat.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM C2 HEADER (ATTRIBUTES A - H) ARE LISTED IN THE FORM A INSTRUCTIONS.

1. REACH NUMBER: Enter the reach in which the Special Cases habitat occurs. (FL:3 (e.g., 999))

2. NSO NUMBER: Enter the NSO number for the Special Cases habitat type as entered to Form C. (FL:4 (e.g., 9999))

3. HABITAT NUMBER: Enter the number of the Special Cases habitat. Like all other habitat types, Special Case habitats, of the five types listed above, are incremented sequentially in an upstream direction and each Special Cases habitat carries an "F" habitat prefix before the habitat number. (FL:4 (e.g., F999))

4. SPECIAL CASE TYPE: Circle the type of Special Cases habitat encountered. See definitions above for each type. (FL:5 (e.g., Chute))

5. STREAM SURVEY MILE: Enter the mapped river mile location of the Special Case habitat. River miles begin at the mouth of the inventoried stream. This mapped distance is completed in the office after the field inventory of the Special Cases habitat has been completed. Record to the nearest river mile. (FL:4 (e.g., 9999))

6. TOPOGRAPHIC ELEVATION: Enter the elevation of the Special Cases habitat identified from the closest contour line on the 1:24,000 scale USGS topographic field map. The topographic elevation is also determined in the office after the field inventory of the habitat has been completed. (FL:4 (e.g., 9999))

7. SIZE: Enter the length, width, and height of the feature, where appropriate.

Falls:	Only height is required.
Chutes:	Length and height are required. Height is defined as the elevational change between the bottom and the top of the chute. To calculate chute height using an Abney level, measure the slope angle of the chute in degrees. The height equals the product of the length of the chute multiplied by the sine of the angle.
Dams:	Length, width, and height are all required. Length is measured parallel to the stream flow, and width is measured perpendicular to the stream flow.
Marshs:	Only length of the valley floor in a marshland condition is required.
Braids:	Estimate the total length of channel in a braided condition (= length), and sum the average wetted width of the braids (= width). All dimensions can be recorded to the nearest 0.1 ft. (Length/FL:5 (e.g., 9999.9; Width/FL:5 (e.g., 9999.9); Height/FL:5 (e.g., 9999.9))

8. GRADIENT: Where applicable, enter the gradient of the Special Case habitat in percent slope, to the nearest percent. This can be determined most easily by dividing the height of the Special Cases habitat by the habitat's length (rise/run). (FL:3 (e.g., 999))

9. POOL PRESENT: Indicate whether a pool is present immediately downstream of the feature. Such a pool need not span the wetted channel (i.e., it need not meet the protocol for a habitat pool). (FL:1 (e.g., Y))

10. POOL DIMENSIONS: If a pool is present, enter the measured wetted dimensions for length, average width, and maximum depth. Record all dimensions to the nearest foot. (Length/FL:2 (e.g., 99)); Width/FL:2 (e.g., 99)); Depth/FL:2 (e.g., 99)

11. OBSERVER/RECORDER: Enter the observer and recorder's names using first initial and surname (e.g., J.Cool).

12. COMMENTS: Enter any pertinent comments for the feature. (FL:240 (e.g., falls is actually a series of three steps with no intervening pools))

STREAM HABITAT DATA FORM C2
(FALLS, CHUTES, DAMS, MARSHES, BRAIDS)
R6-2500/2600-24

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ____

F. Watershed Code ___, ___, ___, ___ NFS ___,___;___.___,___.___,___.___,___.___

G. USGS Quad ____

H. Survey Date ____-______-____

DD-MMM-YY

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Habitat # _______
4. Special Case Type (circle)

Falls Chutes Dams Marshes Braids

5. Stream Survey Mile ____________ (ft) 6. Topographic Elevation ____________
7. Size: Length ______________ Width ____________ Height ______________
8. Gradient ______________ 9. Pool Present ________________
10. Pool Dimensions: L_____ W_____ D_____
11. Observer/Recorder ______________________________________
12.Comments ______________________________________

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Habitat # _______
4. Special Case Type (circle)

Falls Chutes Dams Marshes Braids

5. Stream Survey Mile ____________ (ft) 6. Topographic Elevation ____________
7. Size: Length ______________ Width ____________ Height ______________
8. Gradient ______________ 9. Pool Present ________________
10. Pool Dimensions: L_____ W_____ D_____
11. Observer/Recorder ______________________________________
12. Comments ______________________________________

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Habitat # _______
4. Special Case Type (circle)

Falls Chutes Dams Marshes Braids

5. Stream Survey Mile ____________ (ft) 6. Topographic Elevation ____________
7. Size: Length ______________ Width ____________ Height ______________
8. Gradient ______________ 9. Pool Present ________________
10. Pool Dimensions: L_____ W_____ D_____
11. Observer/Recorder ______________________________________
12. Comments ______________________________________

COMMENTS - FORM C3, R6-2500/2600-25

The function of the Comments form is to provide additional space, if needed, for any comments concerning habitat condition, observed biota, riparian condition, upland condition, etc. that won't fit in the "Comments" space provided on each of the field forms (Forms B2, C, C1, C2, and D.). Consider developing codes for recurring comments (such as RW for a root wad); this will assist in querying data at a later time.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM C3 HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS)

1. REACH NUMBER: Enter the number of the reach where the observation is made. (FL:3 (e.g., 999))

2. NATURAL SEQUENCE ORDER (NSO): Enter the NSO for the habitat which is the focus of the comment as listed on Form C. (FL:4 (eg.9999))

3. HABITAT TYPE AND NUMBER: Enter the habitat type and number of the habitat which is the focus of the comment as listed on Form C. (FL:5 (e.g., MR999))

4. COMMENTS: Enter your comments regarding any of the above evaluations and photos; or geomorphological, hydrologic, or biological observations here. For culverts use Form C1, and for falls, chutes, dams, marshes, and braided channels use Form C2 to document specific information regarding these features. Other suggested features to note are:

Fish passage: jams, barriers, fish habitat improvement opportunities, etc.

Watershed concerns: landslides, erosion areas, streambank damage, watershed rehabilitation potential, etc.

LWD: wood intercepting bankfull flow in a dry main channel. LWD along a dry channel must be recorded with the nearest pool or riffle to tally the wood in SMART.

Bankfull dimensions: not measured in a measured riffle. A comment identifying the riffle used to determine bankfull and floodprone dimensions must be made whenever the actual measured riffle lacks clear bankfull indicators.

Other: diversions, mining, dredging, filling, riprap, etc. Also include reaches that are within Wild and Scenic rivers and wilderness areas.

Tributaries: Note the habitat unit at the confluence, estimated tributary discharge, the channel gradient of the tributary immediately upstream of mouth, and the percent contribution to the flow of the mainstem stream.

End of Survey: Note the reasons for ending the inventory at a given point. The upstream endpoint for the inventory must be geographically defined so that the point can be reestablished in the future. If possible, mark beginning and end of each reach with metal tag to tree and define in "Comments" section.

This information will give the reviewer insight as to the reasoning for ending the survey, and will minimize the need to re-examine that point in the watershed. (FL:240 (e.g., riparian buffers intact, 10-yr old revegetation on upland R.BANK slope))

STREAM HABITAT DATA FORM C3
R6-2500/2600-25

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ______________________________

F. Watershed Code ___, ___, ___, ___ NFS ___,___;___.___,___.___,___.___,___.___

G. USGS Quad ______________________________

H. Survey Date ____-______-____

DD-MMM-YY

Reach Number	Natural Sequence Order (NSO)	Habitat Type and Number	Comments

FISH AND AMPHIBIAN DISTRIBUTION - FORM D, R6-2500/2600-30

This form is to be used to document the range and distribution of aquatic-dependent species identified during the inventory. Although the focus is on those species that are dependent on water for all life stages (fish), amphibians are to be noted. Sampling methods will focus on those specific to collecting/observing fish species. The sampling intensity may vary between Forests, but the minimum standard is to establish the range of species throughout the section of inventoried stream. Consider sampling at each 10th pool and 15th riffle. Snorkeling, electroshocking, or seining or hook and line methods may be used to gather this information. Species must be directly observed to be identified. At a minimum, identify to the genus level; where possible, to the species level.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM D HEADER (ATTRIBUTES A - H) ARE LISTED IN THE FORM A INSTRUCTIONS)

I. REACH NUMBER: Enter the number of the reach where sampling occurred. (FL:3 (e.g., 999))

J. METHOD: Circle the method used for collection/identification. (FL:2 (e.g., SN))

1. NATURAL SEQUENCE ORDER (NSO): Enter the Natural Sequence Order as listed in Form C of the habitat in which the fish and/or amphibian identification occurred. (FL:4 (e.g., 9999)).

2. HABITAT TYPE AND NUMBER: Enter the habitat type and number assigned to the NSO described in #1 (above) as listed in the Form C. (FL:4 (e.g., P999))

3. SPECIES: If only identified to genus, enter the first 2 alpha characters of the genera, and denote species by XX. If identified to species, enter the first two letters of the genus, followed by the first two letters of the species. If additional identifiers are desired, the last 2 spaces will accommodate two more letters. For example, these additional letters would allow steelhead and rainbow trout which are the same species *(Oncorhynchus mykiss* = ONMY) to be uniquely identified as ONMYAN (ONMY anadromous) and ONMYRE (ONMY resident).

Amphibian species can be treated in an identical manner using a four-letter code designating genus and species for all amphibians encountered. There are two field guides that can provide surveyors with excellent color photos, a species description, a brief discussion of habit and habitat, and distribution maps for each amphibian species: *Amphibians of Oregon, Washington and British Columbia: A Field Identification Guide*, by Charlotte C. Corkran and Chris Thoms and *Amphibians of Washington and Oregon: The Trailside Series,* by William P. Leonard et al. (FL:6 (e.g., SACOFL))

4. COMMENTS: Enter comments regarding any of the evaluations and document photos. Additional comments might include geomorphic, hydrologic, or biological observations. (FL:240 (e.g., several stream restoration structures in this reach offering excellent cover for juvenile trout))

While the FS is responsible for the stewardship of habitat for fish and amphibians, it is the state agencies which remain empowered to protect the species. Both Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife require personnel engaged in sampling fish populations obtain a permit. A federal permit is required to snorkel, seine, or electroshock in any stream that has fish or wildlife with federal status at "threatened" or "endangered." The U.S. Fish and Wildlife Service has jurisdiction over resident fish and wildlife; the National Marine Fisheries Service is the permitting agency for salmon and other anadromous fish.

PARTIAL LIST OF FISH AND AMPHIBIAN SPECIES

CODE	GENUS AND SPECIES	COMMON NAME
CAXX	*Catostomus* sp.	Unknown sucker
COXX	*Cottus* sp.	Unknown sculpin
GAAC	*Gasterosteus aculeatus*	Threespine stickleback
GIBI	*Gila bicolor*	Tui chub
JUVL	....	Unknown juvenile salmonid
ONCL	*Oncorhynchus clarki*	Cutthroat trout
ONGO	*Oncorhynchus gorbushcha*	Pink salmon
ONKE	*Oncorhynchus keta*	Chum salmon
ONKI	*Oncorhynchus kisutch*	Coho salmon
ONMY	*Oncorhynchus mykiss*	Steelhead, Rainbow, Redband trout
ONNE	*Oncorhynchus nerka*	Sockeye salmon
ONTS	*Oncorhynchus tshawytscha*	Chinook salmon
ONXX	*Oncorhynchus* sp.	Unknown salmon/trout
PRWI	*Prosopium williamsoni*	Mountain whitefish
PTOR	*Ptychocheilus oregonensis*	Northern squawfish
RHCA	*Rhinichtyhs cataractae*	Longnose dace
RHXX	*Rhinichthys* sp.	Unknown dace
SACO	*Salvelinus confluentus*	Bull trout
SAFO	*Salvelinus fontinalis*	Brook Trout
SATR	*Salmo trutta*	Brown Trout
AMGR	*Ambystoma gracile*	Northwestern salamander
AMTI	*Ambystoma tigrinum*	Tiger salamander
ASTR	*Ascaphus truei*	Tailed frog
BAWR	*Batrachoseps wrighti*	Oregon slender salamander
BUBO	*Bufo boreas*	Western toad
BUWO	*Bufo woodhousii*	Woodhouse's toad
DICO	*Dicamptodon copei*	Cope's giant salamander
DITE	*Dicamptodon tenebrosus*	Pacific giant salamander
ENES	*Ensatina eschoscholtzii*	Ensatina
PLEL	*Plethodon elongatus*	Del Norte salamander
PLDU	*Plethodon dunni*	Dunn's salamander
PSRE	*Pseudacris regilla*	Pacific chorus frog
RAAU	*Rana aurora*	Red-legged frog
RABO	*Rana boylii*	Foothill yellow-legged frog
RACA	*Rana cascadae*	Cascades frog
RAPI	*Rana pipiens*	Northern leopard frog
RAPR	*Rana pretiosa*	Spotted frog
RHCA	*Rhyacotriton cascadae*	Cascade torrent salamander
SPIN	*Spea intermontana*	Great Basin spadefoot
TAGR	*Taricha granulosa*	Roughskin newt

STREAM HABITAT DATA FORM D
R6-2500/2600-30

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ______________________________

F. Watershed Code ___, ___, ___, ___ NFS ___,___;___.___,___.___,___.___,___.___

G. USGS Quad ______________________________

H. Survey Date ____-______-____

DD-MMM-YY

I. Reach Number ____________

J. Method (circle method used for collection/identification)

Seine (S) Snorkel (SN) Electroshock (E) Hook & Line (H)

Natural Sequence Order (NSO)	Habitat Type and Number	Species	Comments

CHAPTER 4

SPECIALIZED FIELD PROCEDURES: DISCHARGE AND WOLMAN

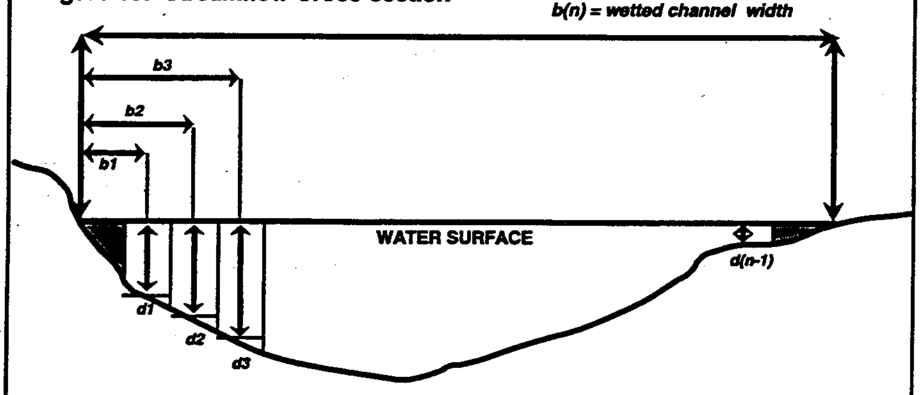
STREAM HABITAT DATA FORM E, R6-2500/2600-31

The level II stream inventory is designed to identify habitats during low streamflow conditions. On most stream in the Pacific Northwest, low flow occurs in the summer. Habitats with only slight turbulence during low flow conditions are often quite turbulent as streamflow (discharge) increases. By measuring discharge at the beginning of the field inventory, mangers are able to compare inventories completed during different years on the same stream.

Stream discharge (Q) is the volume of water passing a cross-section per unit of time and is generally expressed as cubic feet per second (cfs). Discharge is simply the velocity multipled by the cross-sectional area of the stream (Q=VA). Cross-sectional area is the vertical plane of water filling the channel, and this plane is always perpendicular to the thalweg. Area is approximated by dividing the wetted cross-section into subsections. The depth and width of each subsection are determined. Velocity is measured in each subsection using a current meter. The discharge for each subsection is calculated and the subsectional discharges are summed to derive a total stream discharge.

The figure below displays the mid-section method for dividing the stream cross-sectional area into subsections. The distance "b_n" is the width of the wetted channel. The distance, "b," represents the distance from the initial point ("O") to the location of the first depth and velocity measurements. The dotted lines indicate the vertical boundaries of each subsection, with the measured depth and velocity of each subsection occurring along the midline of the subsection.

Figure 15: Streamflow Cross-section



Three rectangular subsections are displayed by depth and distance from the water's edge to the midline of each subsection. The shaded triangles represent the stream margin, with a depth too shallow to measure velocity. The stream margins make a negligible addition to streamflow.

The best place to measure discharge is where laminar flow dominates and the flow is perpendicular to the cross-section. These conditions exist in gravel dominated riffles or pool tail outs. Seek a cross-section where smaller subtrates dominate (cobble or finer) and turbulence is minimized.

Water in a channel flows at different rates depending on its location, so the area of the cross-section is divided into subsections, with one or more measurements taken for each. At least 25 to 30 subsections are needed for most channels, and no more than 10 percent of the total dicharge (Q) should pass through any subsections. Add additional subsections for broad or structurally complex cross-sections.

For computing the area, the mid-section method (see figure above) uses the vertical line of each measurement as the centerline of a rectangular subsection; boundaries fall halfway between the centerlines. Discharge in the triangular subsections at the water's edge, where the water is too shallow to allow a meter reading, are negligible in terms of total discharge.

Multiply the mean velocity for each subsection by the area of the subsection to compute the discharge (Q_n) for the subsection. Sum all subsection discharges to get the total discharge (Q) for the cross-section.

The field procedure is much like measuring elevations along the cross-section, except a current meter is used instead of a stadia rod. A two-person crew works best, one to operate the current meter and one to take notes. In high gradient or deep streams, use appropriate safety precautions.

CURRENT METERS. Meters commonly used to measure current velocity include: Marsh-McBirney, Swoffer, Price AA, and Pygmy. Some brands have rotating cups, while others have a pair of electronic contacts on a small head. Older models read out revolutions of the cups by clicking or buzzing into a headset. Newer models have a digital read-out.

Most current meters mount on a top-setting rod, which allows the current meter to be easily set to the correct depth. Top-setting rods are recommended for discharge measurement because they make the process simpler and quicker.

Examine the meter before going into the field, and read the manufacturer's instructions. Some meters (i.e., Price AA and Pygmy meters) will require a spin test before each measurement; a short series of strong breaths on a Pygmy should yield a minimum spin of 30 seconds. Or perhaps even test it in running water--using a nearby stream, irrigation ditch, or a garden hose aimed at the cups. Check the batteries providing power to the digital read-out, and take spares. Calibrate your meters prior to the field season. If you have more than one meter, compare results from the same cross-sectional point, and calibrate the meters as necessary. Meter calibration services are available from the USGS and universities.

PROCEDURE FOR CURRENT VELOCITY MEASUREMENT

1. Stretch a measuring tape between the endpoints of your wetted channel, perpendicular to the flow. The location of the measuring tape is the cross-section, and as such, it is acceptable to rearrange the streambed to promote laminar flow. It is best to remove the larger streambed particles causing irregular flow both upstream and downstream of the tape before beginning to measure velocity with the meter.

After streambed manipulation, divide the distance between the water's edges by 25 (at least) to set the interval for metering (e.g., the water surface is 22 feet across, 22 ÷ 25= an interval of 0.88 feet, which can be rounded down to 0.8 to ensure a minimum of 25 subsections). Use closer intervals for the deeper parts of the channel or wherever you suspect flow through the subsection to exceed the 5 percent limit.

2. Start at the water's edge and call out the distance first, then the depth, then the velocity. Stand downstream from the current meter in a position that least affects the velocity of the water passing the meter. Hold the rod in a vertical position with the meter directly into the flow. Stand approximately 1 to 3 inches downstream from the tape and at least 18 inches from the meter.

3. To take a reading, the meter must be completely under water, facing into the current, and free of interference. The meter may be adjusted slightly upstream or downstream of the tape measure to avoid cobble, boulders, or other obstructions. The recorder will call out the calculated distance for each velocity reading; however, the observer is free to change that distance (e.g., take velocity and depth readings at closer intervals through the thalweg).

- ☞ Take one or two velocity measurements at each subsection.
- ☞ If depth (d) is less than 2.5 ft., measure velocity (v) once for each subsection at 0.6 times the total depth (d) measured from the water surface (e.g., if d is 2 ft., measure at 1.2 ft. from the water surface, or 0.8 ft. above the bottom).
- ☞ If depth (d) is greater than 2.5 ft., measure velocity (v) twice, at 0.2 and 0.8 times the total depth (e.g., if d is 3 ft., measure at 0.6 ft. and 2.4 ft. from the water surface). The average of these two readings (+) is the velocity for the subsection.
- ☞ Allow enough time for each reading--a minimum of 40 seconds for most meters. The observer calls out the distance, then the depth, and then the velocity. The note taker repeats it back as it is recorded; this provides a check on the team's communication. Readings from some meters are simply a count of revolutions by the meter and must be converted by the note taker, while others read out digitally in feet-per-second.

4. The recorder will calculate the partial stream discharge for each subsection, and finally sum all of the subsectional discharges to determine the total discharge of the stream. If any of the subsections has a discharge greater than 5 percent of the stream's total discharge, the "problem" subsections will be further divided into smaller subsections such that none of these smaller partitions will exceed the 5 percent limit.

5. The observer will measure new depths and velocities at the midline of each of these smaller subsections. The recorder will calculate the partial stream discharge in each of the small subsections and sum these values. This new sum will replace the sum of discharges for all original subsections carrying more than 5 percent of the total stream discharge, and a new stream discharge will then be calculated.

COMPUTING DISCHARGE

When the velocity measurement is complete, calculate the total discharge (Q). Determining total discharge accurately is a complex issue, and a variety of methods and equations exist. The mid-section method is currently recommended by the USGS.

The following formula defines the basic method for calculating discharge:

$$Q = \sum (a\,v)$$

Where Q is the total discharge; a is the area of a rectangular subsection, the product of width (w) and depth (d) for that subsection; and v is the mean velocity of the current in a subsection.

1. Using the mid-section method, compute the area (a_n) of each subsection:

$$a_n = d_n \frac{b_{(n+1)} - b_{(n-1)}}{2}$$

Where b is distance along the tape from the initial point. "Lost" discharge in the triangular cross-sectional areas at the water's edges is assumed to be negligible.

2. Next, multiply the subsectional area (a_n) by the mean velocity (v_n) for the subsection; the result is the subsectional discharge (Q_n). If only one velocity measurement was taken at 0.6 depth, that value is the mean velocity (v_n). If two measurements (v_1 and v_2) were taken at 0.2 and 0.8 depth, compute the mean value as:

$$v_n = \frac{v_1 + v_2}{2}$$

3. To compute the discharge for each subsection, use the equation:

$$Q_n = a_n v_n$$

Where:

Q_n= discharge for subsection n,
a_n= area of subsection n, and
v_n= mean velocity for subsection n.

The calculation is repeated for each subsection, as shown below:

$Q_1=a_1 v_1$, $Q_2=a_2 v_2$, $Q_3=a_3 v_3$, and so on...

4. The subsection products are then added to get total discharge (Q):

$Q = Q_1 + Q_2 + Q_3 + Q_4 + Q_5$ and so on...

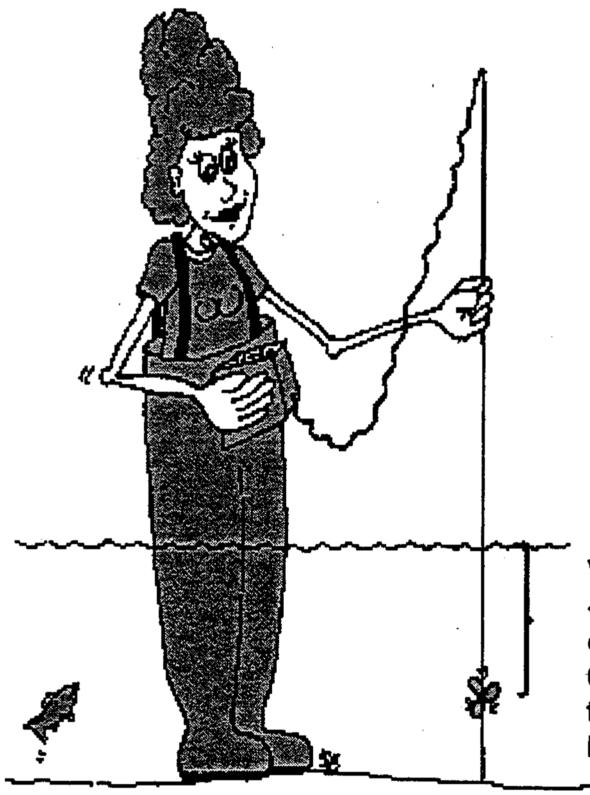
Thus, total discharge (Q) equals the sum of all subsectional discharges ($\sum$ (a v)), as stated earlier in the basic equation:

$$Q = \sum (a\ v).$$

If you have any questions about this computation, draw a hypothetical cross-section, assign current velocities (from 0 to 5 ft. per second) to each subsection, assign a depth to the midline of each subsection, and work out a sample discharge before going to the field. Field crew members should understand this procedure and be able to compute sample discharges before field work begins.

Reference:
Harrelson, C.C, C.L. Rawlins and J.P. Potgondy, *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, General Technical Report RM-245, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Co. 1994.

Figure 16: Water velocities are measured at 6/10 of the water column depth



Water velocities (in depths <2.5 feet) are taken at 6/10 of the water depth (i.e., 6/10 of the distance from the water's surface to the bottom).

STREAM HABITAT DATA FORM E
R6-2500/2600-31

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District ____________

E. Stream Name ____

F. Watershed Code ___, ___, ___, ___ NFS ___,___,___,_____._____,_____._____,_____._____

G. USGS Quad ____

H. Survey Date ____-_____-____ I. Observer/Recorder ______________________
DD-MM-YY

J. Meter Type ________________ K. Remarks ______________________________

Distance from initial point (ft)	Width (ft)	Depth (ft)	Observation Depth (ft)	Revolutions	Time in Seconds	Velocity at point (ft/sec)	Velocity Mean in Vertical (ft/sec)	Area (ft^2)	Discharge (cfs)

STREAM HABITAT DATA FORM F, R6-2500/2600-32: WOLMAN PEBBLE COUNTS

PROCEDURE: The Wolman pebble count will be performed two times in each stream reach identified during the level I (office phase) inventory as delineated on the field map. One pebble count will be completed at approximately one-third and a second pebble count will occur at two-thirds of the total reach length. The riffle chosen for each pebble count should possess what is perceived to be normal conditions for riffles already inventoried in that reach. The riffle chosen for the Wolman pebble count need not be a measured riffle. It is the surveyors task to determine the normal condition of riffles in each reach. The survey team needs to continually evaluate the following questions.

- What water level gradient is normal in the riffles; less than 4 percent, greater than 4 but less than 10 percent, or greater than 10 percent?
- What substrate types best represent the reach; bedrock is common, cobble and gravel dominate, sand/silt/clay is common, etc.?
- Is LWD a common component of riffles?
- Are the banks actively eroding in most riffles?
- Are side channels commonly associated with riffles in the reach?

While the answers to these questions may change as more of the reach is observed, these channel characteristics will provide guidance in selecting a riffle that is representative or average for the reach. The first Wolman pebble count is performed in a representative riffle located at one-third of the reach's length; the second Wolman pebble count is performed in a riffle that is representative of the reach at two-thirds of the reach's length.

The pebble count technique (Wolman 1954) has long been used by geomorphologists, hydrologists, and river engineers to characterize rivers which flow on coarse material and are wadable during low flows. The procedure has recently been recognized by fishery biologists as a better alternative to characterize substrate than the visual estimation techniques commonly used in fisheries and instream flow studies. In addition, pebble counts are used on many National Forests as monitoring tools to evaluate entry of fine sediment into streams.

For monitoring purposes, a selected site is often measured for several years. Generally, individuals are interested in measuring changes to surface fines (i.e., sand, silt, or clay) due to management activities such as timber harvest, fire, or road construction. It is widely accepted that an increase in fines in stream channels is detrimental to fisheries.

Several different schemes can be adopted to provide the minimum 100 tallies of substrate. One transect of 100 equally-spaced tallies can be selected, or two transects of 50 tallies each, or any combination that is linear and equates to at least 100 samples of the streambed. It is common to tally an excess of 100 samples, but avoid having less than 100. The transects must run from one edge of the bankfull channel to the opposite edge of the bankfull channel. These transects need not be perpendicular to the flow, but they must span the entire bankfull channel, with both the first and last substrate tally of each transect occurring at bankfull stage. <u>Do not</u> limit the sampling to the wetted channel! A zigzag set of transects is commonly employed through the chosen riffle.

As the channel dimensions decrease and habitats become smaller, it may be difficult to perform a complete Wolman pebble count in a single riffle. In such cases, it is quite acceptable to perform some of the tallies in pools, provided the transect chosen does not intentionally avoid the deeper portions of the pool. Whenever pools are included in the Wolman pebble count, the percent of tallies in pools should approximate the percent that pool habitat comprises of the total habitat of the reach.

THE PEBBLE COUNT TECHNIQUE. A pebble count consists of a random selection of at least 100 particles from the streambed. Individual pebbles can be selected from a grid system, but more commonly pebbles are selected from the toe of the boot along a toe-to-heel transect which traverses the stream from bankfull stage to bankfull stage. The intermediate axis of each pebble, defined as neither the longest nor the shortest of three mutually perpendicular axes of a particle, is measured. The intermediate axis can be visualized as that dimension of the pebble which controls whether or not it would pass through a soil sieve.

The greatest source of bias in pebble counting is associated with the manner in which observers pick up particles. The natural tendency is to select larger rocks. To avoid this, observers will need to consistently use a fixed reference point, such as a mark on the tip of a boot, and a fixed point on the tip of the finger that descends into the water to select the particle for measurement. To limit the visual bias towards larger substrate, the observer should extend their finger over the boot without looking until the streambed is touched. The first particle touched by the tip of the finger will be measured. Because the technique requires physically picking up particles, it is commonly limited to wadable streams. Particles too large or too well cemented into the streambed to be removed must be estimated. Whenever possible, measure the lesser of the two exposed axes and record in the appropriate size class. In certain situations, the depth of the channel may impede sampling. Surveyors are encouraged to determine the dimensions of their boots so that the boots' width and length may be used as a surrogate for a millimeter ruler.

Pebbles down to 2 mm in size (very coarse sand) will be directly measured and tallied in the appropriate size class. Sand, silt, and clay particles will be tallied as "less than 2 mm". Wolman pebble counts also have a built-in bias against fine sediment due to the precision of selecting individual pieces of substrate. Numbing due to cool stream temperatures, low visibility in turbulent water, and our visual bias for larger substrate reduce the ability to accurately record fines (sand, silt, and clay) as streambed substrate tallies. By carefully lifting the finger from the streambed, the observer can reduce the bias against fine sediment. If a plume or cloud of fine sediment is released as the finger lifts, the tally should be in the "less than 2 mm" size class. Caution should be taken to recognize the difference between the organic material coating many streambed particles (= algal scum) and fine inorganic sediment resting atop larger particles of the streambed.

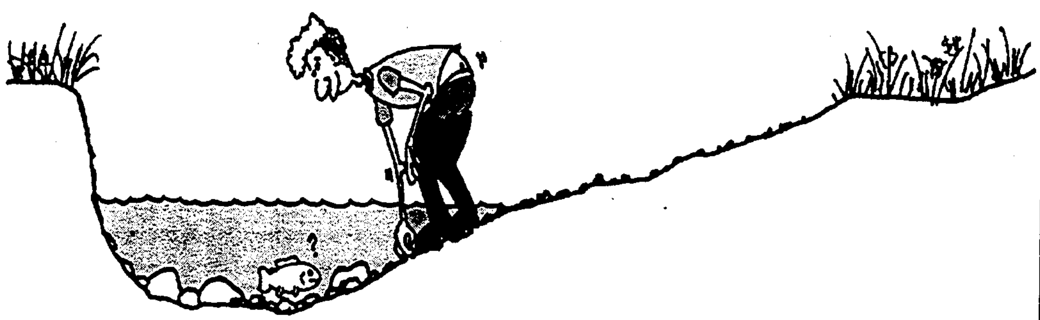
The number of pebbles in each size class will be tabulated and converted into percentages. Data will be plotted as a cumulative size distribution curve. "Cumulative percent finer" will be plotted on the y-axis, and "particle size" expressed as the upper limit of each size range will be plotted on the x-axis. "Particle size" classes and cumulative percent finer versus size are shown on Form F. While any bedrock encountered as tallies during the Wolman procedure should be recorded, the tallies are not graphed. This is due to the absurdity of graphing an "upper limit" to the size of bedrock. In such cases, the graph will form an asymptote at the cumulative percent finer than 4096 mm.

The resulting frequency distribution represents the percent of the streambed covered by particles of a certain size since each pebble represents a portion of the bed surface. Results are theoretically equivalent to size distributions obtained from bulk samples.

The entire width of the bankfull channel is investigated, and the rocky particles of the streambed are grouped by their size. A frequency distribution by size class is graphed, and the resultant curve is used to make inferences about channel dynamics. During bankfull flows, it is expected that all particles smaller than the median value (D_{50}) displayed on the curve will be mobile, and this same value further refines the Rosgen channel type for that reach. In a similar sense, particles larger than the 84th percentile (D_{84}) will comprise the immobile portion of the streambed during bankfull discharge.

References:
King, R, Potyandj, J. 1993. *Statistically Testing Wolman Pebble Counts: Changes in Percent Fines!* Stream Notes, USDA Forest Service.
Rosgen, D.L. 1996. *Applied River Morphology.* Wildland Hydrology,
Wolman, M.G. 1954. *A method of sampling coarse river-bed material.* Transactions of the American Geophysical Union. 35(6): 951-956.

Figure 17: General guidelines for doing pebble counts



bankfull width = pebble count transect

Pebble Count "Hints":

1) Always begin a transect at the edge of the bankfull channel and end each transect at the opposite edge of the bankfull channel.
2) Measure at least 100 "pebbles" (but, don't stop measuring untilyou reach the end of the transect atop the bankfull indicator).
3) Measure the first "substrate element" you touch at each designated sample location.
4) Substrate is measured across the intermediate axis, (neither the longest nor shortest of the three mutually perpendicular axes).
5) Pebble counts are usually done in riffles (twice per reach).
6) If you don't get 100 measurements on a transect, continue to do transects within the riffle until you meet or exceed 100 measurements.
7) Two pebble counts should be done for each reach, in riffle habitats. The riffles should be located about 1/3 and 2/3 of the total length of each reach. Use your map (developed during the completion of Form B1) to locate the section of stream in which the sample riffles will be located.

*** for additional information, see Harrelson, et al. 1994.**

STREAM HABITAT DATA FORM F
R6-2500/2600-32

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name____.

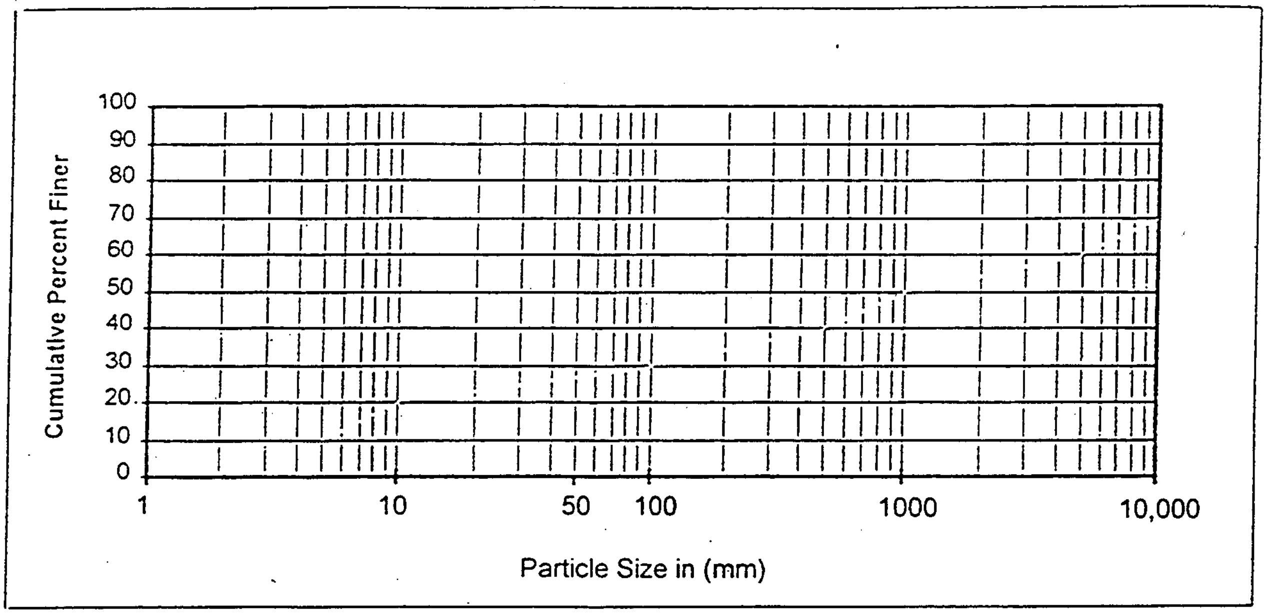
Watershed Code ___, ___, ___, ___ NFS ___,____.____,_____.____,____.____,____.____

G. USGS Quad ____

H. Survey Date ____-______-____ I. Observer/Recorder ______________________________

DD-MMM-YY

PEBBLE COUNT							
Stream Name:				Survey Date:			
NSO #:				# of Transects:			
Surveyor:				Reach:			
Inches	PARTICLE	Millimeters		Particle Count	Total #	Item %	% Cum
< .08	< Sand	< 2	S/C/S				
.08 -.16	Very Fine	2 -4					
.16 - .22	Fine	4 -5.7	G				
.22 - .31	Fine	5.7 - 8	R				
.31 - .44	Medium	8 -11.3	A				
.44 - .63	Medium	11.3 - 16	V				
.63 - .89	Coarse	16 -22.6	E				
.89 - 1.26	Coarse	22.6 - 32	L				
1.26 - 1.77	Vry Coarse	32 - 45	S				
1.77 -2.5	Vry Coarse	45 - 64					
2.5 - 3.5	Small	64 - 90	C				
3.5 - 5.0	Small	90 - 128	O				
5.0 - 7.1	Large	128 - 180	B				
7.1 - 10.1	Large	180 - 256	L				
10.1 - 14.3	Small	256 - 362	B				
14.3 - 20	Small	362 - 512	L				
20 - 40	Medium	512 - 1024	D				
40 - 80	Large	1024 -2048	R				
80 - 160	Vry Large	2048 -4096	S				
	Bedrock		BDRK				
				Totals:			
	Total Tally:						


Cumulative Percent Finer
100
90
80
70
60
50
40
30
20
10
0
1
10
50
100
1000
10,000
Particle Size in (mm)

APPENDIX A
WATERSHED CODES

Nationally, the USDI Geological Survey and the Water Resources Council have established a coordinated watershed delineation and coding system which is referred to as the Hydrologic Unit Codes (HUC). This system is hierarchical and is comprised of Region, Subregion, Accounting Unit, and Cataloging Unit. The Accounting Unit is generally referred to as a river basin and the Cataloging Unit is usually known as a subbasin. An example of this type of coding is:

Region	Pacific Northwest	17
Subregion	Upper Columbia	1707
Accounting Unit	Deschutes River Basin	170703
Cataloging Unit	Upper Deschutes River Basin	17070301

The Forest Service has added an additional two levels of finer resolution to the HUC coding system to define specific watersheds within a forest. The structure for these two fields (watershed and subwatersheds) is displayed below.

Watershed	Tumalo Creek	17070301 02
Subwatershed	Bridge Creek	17070301 02A

Watershed can be divided into a maximum of 25 subwatersheds denoted by a letter of the alphabet. The letter "O" cannot be used to designated a subwatershed because of the potential to mistake it for zero. All districts should have a good quality watershed map showing the location of all watersheds and subwatersheds.

The Region 6 Standardization Stream Survey Methodology has adopted additional criteria to specifically identify every stream and tributary within a subwatershed.

Under NFS code on Form A there are up to four entries for stream mile measurements to identify the specific stream within the NFS watershed (2 digit code) and subwatershed (1 letter code). These four entries (each 4 characters long) are used to record measured stream miles upstream of the confluence with the next highest hierarchical order) stream. **ALL MILEAGES UNDER THE NFS CODE SHOULD START AT THE MOUTH OF THE MAINSTEM WHICH FORMS THE NFS SUBWATERSHEDS AND PROCEED UPSTREAM UNTIL THE SPECIFIC SURVEYED TRIBUTARY IS REACHED.**

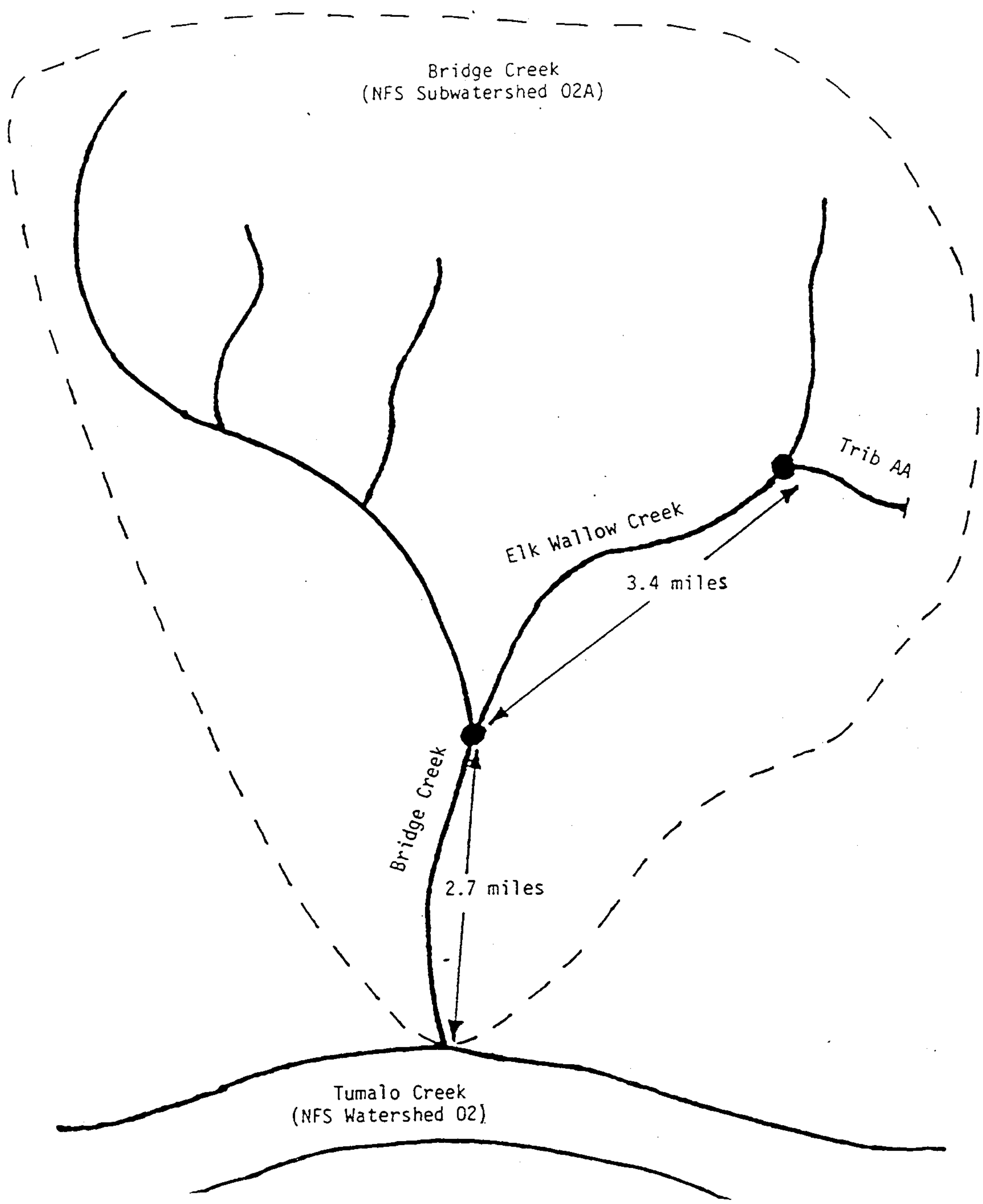
As an example, Tributary AA is a stream to be surveyed. This unnamed tributary flows into Elk Wallow Creek at river mile 3.4, which then flows into Bridge Creek at river mile 2.7 (refer to diagram). The four fields must have 4 digits (2 before and 2 after the decimal) in order for the program to accept them during data entry. Using the above river mileages, stream delineation coding would look something like this:

17070301,	02,	A	02.70 03.40,	____,	____	____
HUC code	Watershed code	Sub-basin code	River miles			

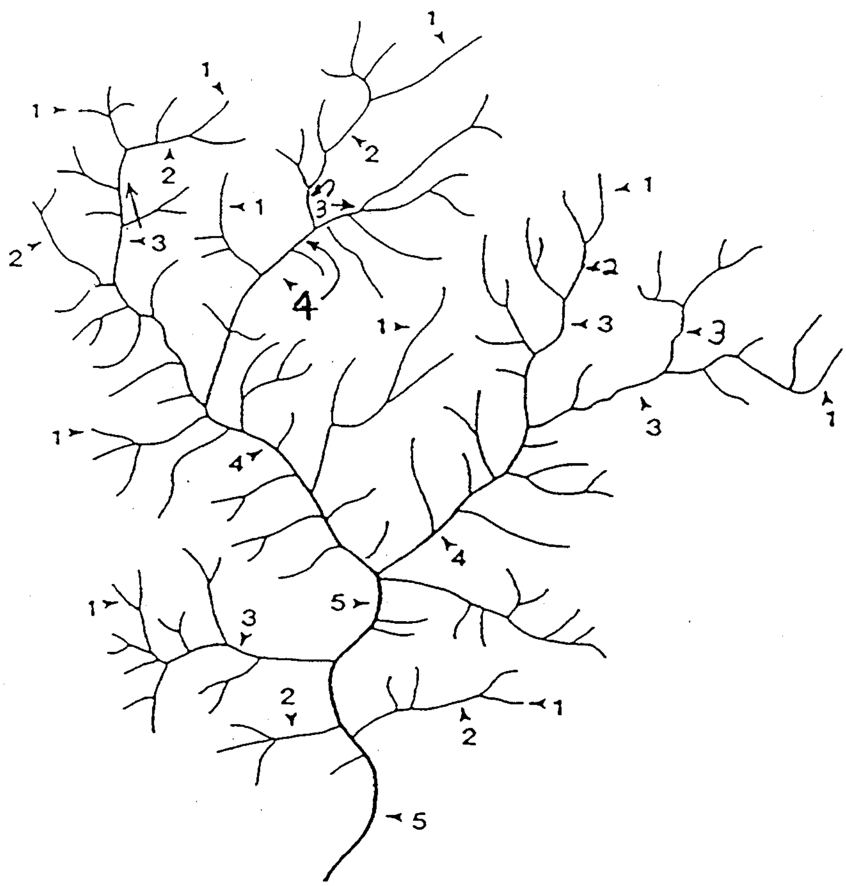
This procedure can be taken an additional two steps to further delineate other tributaries. These mileage measurements designate nodal points at confluences of streams.

To ease clarification, the tributary that has the greatest length from the mainstem confluence to the headwaters will be considered as the mainstem.

In cases where the mouth of the mainstem is an estuary or lake, estimate the stream mileages for tributary junctions along your best guess of what would be the main channel (based on topographical features).



APPENDIX B
STREAM ORDERS



Use 1:24,000 scale topographic map–count bluelines only.

Stream order: The designations (1, 2, 3, etc.) of the relative position of stream segments in a drainage basin network: the smallest, unbranched, intermittent tributaries, terminating at an outer point, are designated order 1; the junction of two first-order streams produces a stream segment of order 2; the junction of two second-order streams produces a stream segment of order 3; etc. Use of small-scale maps (<2"/mile) may cause smaller streams to be overlooked, leading to gross errors in designation. Ideally, designation should be determined on-the-ground or from large-scale air photos.

APPENDIX C
FOREST OPTIONS

Each Forest is empowered to decide whether certain reach or habitat attributes will be investigated. The following is a list of those options. Forests are encouraged to gather any data they feel is relevant, but it must be recognized that the core data attributes of the Region 6 protocol discussed in Chapter 2 of this handbook are mandatory, unless expressly labeled as a "Forest Option." It is expected that any deviations from the stated Region 6 methods will be completely described in the final stream inventory report mandated for each inventoried stream.

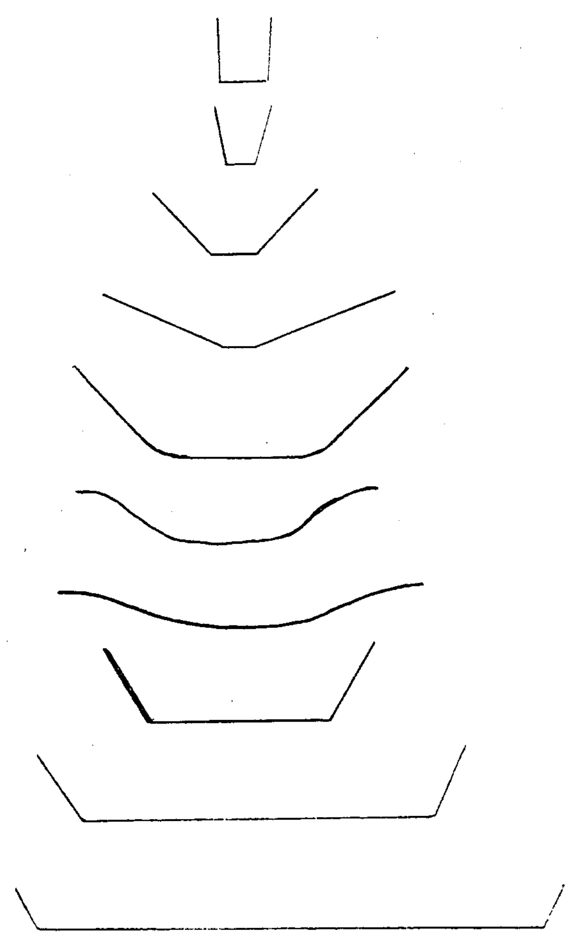
FORM B2

VALLEY FORM CODES: The number codes are used to characterize the floodplain width and upland slopes of each reach and recorded on Form B2 (see accompanying diagram).

VALLEY FORM CODES

Code	Type	Side Slope
1 =	Box-like canyon	Steep: > 60%
2 =	Narrow V-shaped floor width < 100 ft.	Steep: > 60%
3 =	Moderate V-shaped floor width < 100 ft.	Moderate: 30-60%
4 =	Low V-shaped floor width < 100 ft.	Low: < 30%
5 =	U-shaped floor width > 100 ft.	Moderate to steep: > 30%
6 =	Trough-like open short slope lengths	> 30%, mostly 30-60%
7 =	Broad, trough-like	Low: < 30%
8 =	Narrow flat-floored floor width 100-300 ft.	Moderate to steep: > 30%
9 =	Moderate flat-floored floor width 300-600 ft.	Moderate to steep: > 30%
10 =	Wide flat-floored floor width > 600 ft.	Moderate to steep: > 30%

VALLEY CROSS-SECTION



INNER RIPARIAN ZONE WIDTH: Forests can choose to designate the inner riparian zone as 0 ft. wide. This choice is appropriate for a reach or stream, but not for individual habitats. The outer riparian zone width then becomes 100 ft., and 0 ft. is recorded on Form B2 to describe the inner riparian zone width for that reach.

FORM C

HABITAT TYPE: Forests have the option of using the Hawkins method of habitat designation (Hawkins et al. 1993[1]). Hawkins refers to stream habitats as channel geomorphic units which are characterized as either fast water or slow water habitats. These are equivalent to riffles and pools as defined by R06 methods. Fast water habitats are further divided into turbulent and non-turbulent habitats. In a similar fashion, slow water habitats are subdivided into scour pools and dammed pools. Hawkins offers another level of distinction by subdividing turbulent, non-turbulent, scour pool, and dammed pool habitats in the following way:

turbulent -	step cascade rapid riffle chute	non-turbulent -	sheet run glide
scour pool -	glide eddy trench mid-channel convergence lateral scour plunge	dammed pool -	debris dam beaver dam landslide backwater abandoned channel

The SMART update for 1996 permits individual Forests to use two-letter codes to identify habitat types. Forests are empowered to choose a level of habitat designation suited to their management needs, but the minimum habitat designation must distinguish riffles from pools. Each of the various habitats listed above can be assigned unique two-letter codes by each Forest, and each Forest can choose which of these habitats are to be identified during a level II inventory.

PLUNGE POOL HABITAT: Forests are empowered to establish minimum criteria for considering a plunge pool a distinct habitat. Examples of potential criteria include:

- setting a minimum residual pool depth for plunge pools
- classifying only those pools below a channel-spanning accumulation of LWD
- neglecting plunge pools occurring in reaches with valley gradients more than 10 percent

Plunge pools are extremely common in headwall streams. Such streams are often dominated by a complex of stairstep-pools which are actually a series of plunge pools

[1] Hawkins, C.P. et al. 1993. *A Hierarchical Approach to Classifying Stream Habitat Features. Fisheries*, Vol. 18, No. 6.

below transverse bars of cobble and boulder. Establishing a minimum criteria for plunge pools may permit surveyors to more efficiently characterize these high gradient reaches.

AVERAGE DEPTH: Forests can choose to estimate the average depth in riffles to better characterize the channel condition. The estimate is recorded on Form C.

STREAMBED SUBSTRATE: Forests have the choice to estimate the streambed composition by particle size class for every mainstem aquatic habitat. Forests can choose to apply this to the low flow or the bankfull channel. There are five size classes of substrate distinguished by diameter:

Sand:	< 0.08 in.	(< 2 mm)
Gravel:	0.08 to 2.5 in.	(2 - 64 mm)
Cobble:	2.5 to 10 in.	(64 - 256 mm)
Boulder:	10 to 160 in.	(256 - 4096 mm)
Bedrock:	> 160 in.	(> 4096 mm)

If a size class is estimated to comprise less than 6 percent (rounded up to 10 percent) of the total streambed area inundated at the time of the inventory, disregard that size class. If any of the five size classes makes up at least 10 percent of the area, list its contribution in 10 percent increments. The streambed substrate estimate should total 100 percent for each inventoried habitat.

SHRUB/SEEDLING HEIGHT: Forests have the option of recording the shrub/seedling height code in place of the dominant species in the overstory component of both riparian zones. The codes are:

1: 0 to 2 ft. tall
2: 2 to 5 ft. tall
3: 5 to 10 ft. tall
4: > 10 ft. tall

UNDERSTORY DOMINANT SPECIES: Forests must decide what question is of greatest concern. The two most likely questions are:

✓ What tree species dominates the understory component and is likely to replace the overstory dominant tree species if no disturbance removes the overstory?
✓ What species would likely dominate the understory if human impacts were removed?

OPTIONAL FIELDS ON FORM C: These fields are present on Form C to facilitate gathering data of specific interest to individual Forests. Examples of such attributes are percent of stream shaded, percent of riffle habitat possessing pool character, estimated area of available spawning gravels/cobbles, or substrate embeddedness.

RIGHT BANK/LEFT BANK: Each Forest must decide bank orientation. The two options for assigning bank orientation vary based on which direction you are facing: upstream or downstream.

FIELD MAP SYMBOLS: Forests are strongly encouraged to develop and adopt a suite of map symbols which all survey teams would use to better characterize the inventory observations. These symbols should record the important conditions in the aquatic, riparian, and upland components of the drainage basin.

CHANNEL GRADIENT: Forests have the option of field measuring channel gradient. Channel gradient is defined for level II stream inventory as the difference in the elevation of the water level measured at two points along a stream divided by the length of channel between those two points. Gradient can be accurately measured using an abney level or a hand level. In either case, one member of the team (i.e, the surveyor) stands atop water level and sights through the peep hole of the level, while the other team member establishes a measured channel length from the surveyor.

If using an abney level, a reference for the height of the surveyor's eye must be established on the body of the second team member (or on a depth rod). The second crew person stands atop water level (or holds the depth rod atop water level). The surveyor peers through the peep hole of the abney level, locates his or her eye's reference height on the second member of the team (or on the depth rod), and reads channel gradient as a percent directly from the abney level.

If a hand level is used, the second crew person holds the depth rod atop water level. The surveyor peers through the hand level and determines the position along the depth rod which is level to the surveyor's eye. The height along the depth rod level to the surveyor's eye is subtracted from the height of the surveyor's eye. The difference equals the change in elevation across the known channel length. The change in elevation divided by the channel length and multiplied by 100 is equivalent to gradient measured in percent.

HAND HELD DATA RECORDERS: The Region 6 stream inventory professionals have designed and produced a database application specific for data recorders titled, Stream Data Recorder (SDR). This database will permit direct entry of most field attributes to the recorder. The attributes specific to Forms C, C1, and C2 can be entered into the database via keystrokes to SDR using either a Husky data recorder (model FS/2) or a Husky 16. Data entered to the recorder is correctable in the field and can be down-loaded directly to SDR on a PC. Data from SDR can be transferred easily to another PC database or a spreadsheet for quality control checks and data analysis.

Data recorders offer a significant time savings. Most of the computer data entry will occur in the field rather than in the office. Data entered to the data recorder in the field will still require data entry error checks, but the number of field hard copy data sheets will be significantly reduced. However, Form B2 and any "Comments" (Form C3) must still be hand-written in the field and entered to the database via the IBM.

APPENDIX D
SUCCESSIONAL CLASS CODES

Grass/ Forb	Shrub/ Seedling	Sapling/ Pole	Small Tree	Large Tree	Mature Tree
Approximate stand age (years)					
0	5	15	30	80	200 700
	Height Class 1: < 2' 2: 2'-5' 3: 5'-10' 4: >10'	Size: < 8"	Size: 8"-20.9"	Size: 21"-32"	Size: > 32"
GF	SS	SP	ST	LT	MT

Code:

NV = No Vegetation.
The no vegetation condition is characterized by the predominance of bare soil or naked rock.

GF = Grass/Forb condition
The grass/forb stand condition lasts 2-5 years and occasionally as long as 10 years. Shrubs and some trees that sprout are not yet dominant.

SS = Shrub/Seedling condition
The shrub stand condition often lasts 3-10 years but may remain for 20-30 years if tree generation is delayed. Tree regeneration may be common, but trees are generally less than 10-ft. tall and provide less than 30 percent of crown cover.

SP = Sapling/Pole condition
The open sapling/pole condition occurs when trees exceed 10 ft. in height and are between 5 in. and 8.9 in. dbh.

ST = Small Tree condition
The small tree condition has very little ground vegetation because of closed crown canopy. Average stand dbh is 9 in. to 20.9 in.

LT = Large Tree condition
The large tree condition is characterized by trees with an average dbh of 21 in. to 32 in. dbh. An understory of shrubs and young shade-tolerant trees is present.

MT = Mature Tree condition
The mature tree stand conditions are characterized by old live trees, snags, down woody material, and the replacement of some of the long-lived pioneer species such as Douglas-fir by shade-tolerant species such as western hemlock. Size is generally greater than 32 in. dbh.

APPENDIX E
STREAM INVENTORY GLOSSARY

This stream inventory glossary (and the acronym dictionary which follows the Aquatic Glossary), include terms and acronyms used in the body of the Stream Inventory Handbook. The purpose of both of these references is to foster greater understanding of the process and the specifics of stream inventory as defined by the Pacific Northwest Region.

ABNEY LEVEL: A hand held level equipped to measure changes in gradient. These changes in slope are measured in both degrees and percent.

ACCESS POINTS: Locations along the road network used by survey crews to enter or exit the valley of the inventoried stream.

ALLUVIAL: Relating to all deposits resulting directly or indirectly from the sediment transport of streams deposited in riverbeds, flood plains, lakes, fans and estuaries.

AQUATIC HABITAT: (see habitat)

BAFFLES: Deflectors that change the direction of flow or velocity of water through a culvert. Baffles are intended to reduce water velocity and provide passage for fish.

BANKFULL: A term used to describe streamflow which occurs on average once every 1.5 years. Flows of this magnitude transport the most sediment over time. Bankfull flows are the discharge responsible for maintaining the present channel shape. In channel types possessing a well-developed floodplain (e.g., Rosgen streamtype C), bankfull is the stage or streamflow that just overtops the channel's banks and begins to inundate the floodplain.

BANKFULL INDICATORS: The channel attributes created during bankfull flow and visible during low flow conditions. The best indicator of bankfull flow is the deposits of streambed material which remain after a bankfull event. The top of these depositional features closely approximates the height of bankfull flow. Other indicators of bankfull are: the lower limit of perennial vegetation (this may be a change in the species of moss), a change in the streambank's slope, a change in the particle size of the streambank, undercut banks (the top of the undercut is usually slightly lower than the bankfull stage), and the presence of stain lines or the lower extent of lichen colonization on the banks.

BANKFULL STAGE: The water level elevation during a bankfull discharge. This elevation leaves a signature on the channel in the form of depositional areas and distinct streambank slopes. The line of permanent vegetation along a stream is often a close approximation of the bankfull stage.

BOLE: (see tree bole).

BLUELINE CHANNEL OR STREAM: An ephemeral, intermittent or perennial stream which appears as a blue line or dotted blue line on a blueprint copy of a 1:24,000 scale (2.64 in.: mile) USGS topographical map.

BRAIDED CHANNEL: A habitat characterized by the presence of at least three channels running roughly parallel to each other and appearing distinct at flows less than bankfull. At bankfull stage, the islands separating the multiple channels are overtopped, and the channel appears to be a single broad channel. This braided condition describes the Rosgen streamtype D.

The islands separating the braids are characteristically unstable due to their inundation and reformation during bankfull flows. The evidence of this instability is the lack of well-established perennial vegetation atop the islands. A braided channel is the result of a sediment supply that exceeds the power of the stream to transport all of the sediment through a specific channel segment.

CHUTE: A narrow, confined channel through which water flows rapidly. The streambed of a chute is usually composed of bedrock, but may sometimes be made of hard clay. Streamflow is usually laminar through the chute.

COLLUVIAL: Relating to loose deposits of soil and rock moved downslope by gravity alone, rather than by force of flowing water.

COVER: In the sense of cover for fish, anything that provides protection from predators or ameliorates adverse conditions of streamflow and/or seasonal changes in metabolic costs is an attribute providing cover. Instream cover may be provided by substrate, turbulence, undercut banks, woody material, vegetation, or depth. Cover can also be provided by overhanging vegetation or woody debris elevated above the wetted channel. Aquatic organisms use cover for escape, feeding, hiding, or resting. Collecting cover data is a forest option.

Cover for fish is not to be confused with "streambed cover" (an attribute of R06 methods for stream inventory, 1990 to 1994). Streambed cover sought to answer the question, "how well armored are the lower banks to erosion?", and had no direct relation to cover for fish.

CULVERT: A pipe made of metal, concrete, or other material that transports water and sediment beneath a road. Unlike a bridge, a culvert is constructed by burying the pipe in fill material transported to the site. Culverts can be barriers to the upstream movement of fish for several reasons: the length of the culvert or the gradient of the culvert may cause the fish to fatigue and be carried downstream; the velocity of the flow through the culvert may exceed the fish's burst speed; and the height from the surface of the water to the outlet of the culvert may exceed the ability of the fish to jump.

DAM: A human-made structure intended to impound streamflow.

DIAMETER CLASS: As applied to riparian vegetation, diameter is measured or estimated at breast height (DBH) above the ground. The diameter size class is the range of DBH expressed in inches.

In contrast, the diameter of LWD (large woody debris) is measured at the appropriate distance from the large end of the log (see discussion of LWD in Chapter 2 of this handbook.

DISCHARGE: The volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per sec. (cfs) or as cubic meters per sec. (m^3/sec.). Syn: Streamflow.

DESIRED FUTURE CONDITION: An explicit description of the physical and biological characteristics of aquatic and riparian environments believed necessary to meet fish, aquatic ecosystem, and riparian ecosystem objectives.

DOT GRID: A transparent acetate sheet imprinted with regularly spaced dots forming a grid. The dotted sheet is placed atop a map, and the area of the drainage basin is estimated by counting the dots which fall inside the perimeter of the drainage basin.

DRAINAGE BASIN: A part of the surface of the earth that is occupied by a drainage system. This system consists of a surface stream or body of impounded surface water together with all tributary surface streams and impounded surface water. Additionally, a drainage basin always includes the upland slopes which deliver runoff from precipitation directly to the stream network.

DRY MAIN CHANNEL: A habitat characterized by the lack of flowing water during a low flow (level II) survey. This condition is common in intermittent streams. A dry main channel may also occur as a result of water withdrawals, and is sometimes seen in recent deposits of course sediment at the mouths of a stream. A dry side channel is not considered a habitat for the purposes of a level II survey.

ENDPOINTS: (see reach endpoints/startpoints).

ENTRENCHMENT: The ratio of the floodprone width to the bankfull width. As the ratio approaches 1.0, the degree of entrenchment increases. Rosgen streamtypes C, DA, and E have low entrenchment and broad floodplains. In contrast, Rosgen streamtypes A, B, F, and G have high values for entrenchment and poorly developed floodplains.

FALLS: A geomorphic stream channel feature that consists of essentially a vertical drop of water over bedrock or boulders.

FLOOD: Any flow that exceeds the bankfull discharge of a stream or channel. In certain channel types (e.g., Rosgen stream types C, DA and E) discharges greater than bankfull spill out onto a floodplain. In entrenched channel types, flood flows remain constrained by the channel banks.

FLOODPLAIN: The depositional zone near a stream which receives flood water and deposits during streamflows that exceed the bankfull discharge. Floodplains are constructed under the current conditions of flow and precipitation. Entrenched streams tend to lack well-developed floodplains because the water and sediment transported during streamflows which exceed the bankfull stage remain confined within the banks of the channel, rather than being dispersed across a wider valley.

FLOODPRONE WIDTH: The portion of the valley floor potentially inundated during a 50 year flood event.

FOREST OPTION: Optional inventory attributes. Individual forests will decide whether or how to collect these attributes.

GIS: Geographic Information System. GIS produces spatial representations of the condition of the landscape: roads, streams, vegetation, etc.

HABITAT: A channel-wide segment of a stream which has a distinct set of characteristics. A list of potential habitats includes: pools, riffles, side channels, dry main channels, tributaries, culverts, falls, chutes, dams, braided channels, and marshes. Pools and riffles can be thought of as slow water and fast water habitats. These two habitat types can be further classified into subtypes using channel attributes such as turbulence, gradient, position, etc. (See Hawkins, et al. 1993. A hierarchical Approach to Classifying Stream Habitat Features. Fisheries, Vol. 18, No. 6.)

HYDRAULIC CONTROL: A generally sinuous line at the downstream end of a pool where the flow is constricted and stream depth decreases. The top of any channel-spanning obstruction is a hydraulic control if streambed substrate has accumulated upstream of the obstruction forcing streamflow to crest the obstruction. Examples are bedrock outcrops, gravel or cobble bars, log weirs, or beaver dams.

JOURNEY LEVEL PROFESSIONAL: A specialist functioning without a mentor. All program managers regardless of their management unit (e.g., District or Forest) are journey level professionals.

JUMP HEIGHT: The vertical distance a fish would have to jump to pass into a culvert outlet from the downstream habitat. Syn: jumping distance height.

LAMINAR FLOW: Non-turbulent flow. Flow in which the volume of water moves downstream in a fashion similar to water in a smooth pipe, with the particles of water moving parallel to each other. Such conditions are ideal for measuring streamflow. Conditions approximating laminar flow are most commonly found just upstream of a pool tail crest or through a chute.

LARGE WOODY DEBRIS: Live trees or downed wood that intercept bankfull flow in a substantial fashion and are large enough to influence the formation of habitats. For a tree or a downed piece of wood to count as large woody debris, either the root swell or the tree bole must engage bankfull flow; and the wood must be at least 12 inches in diameter at 25 ft. from the larger end of the tree.

LINE (OFFICERS): The operational hierarchy of the Forest Service which includes the District Rangers, Forest Supervisors, Regional Foresters, and the Chief of the FS. These are the individuals empowered to make the decisions about what management activities occur on the landscape.

LOW FLOW: The base flow of a stream. In the Pacific Northwest, low flow occurs on most streams in late summer. It is at low flow conditions that pools and riffles appear most distinct.

MAINSTEM CHANNEL: The main thread of a stream from its mouth to its upstream origin. The mainstem channel is composed of channel-wide habitats such as pools, riffles, dry channels, culverts, falls, chutes, etc. These mainstem channel habitats are linked in a linear fashion to adjacent mainstem habitats, and occasionally linked to secondary channel habitats. Examples of secondary channel habitats are side channels and tributaries.

MAP WHEEL: Instrument used to determine distances on a map. The wheel of the instrument is rolled along a given line on a map. The distance traveled by the wheel is calibrated to the scaled distance of that map (e.g., 2.6 in. = 1 mi.), and a mapped distance is determined.

MARSHLAND: Land characterized by soils that are water-saturated at least part of the year. This wetland lacks a well-defined bankfull channel.

ORACLE: A relational database used throughout the US Forest Service for information management. SMART is an application of the ORACLE database designed to manage data collected during stream inventory.

ORTHOPHOTOGRAPH: A photograph having properties of orthographic projection (i.e., the image displacements caused by camera tilt and relief of terrain are removed from a conventional perspective photograph).

OVERSTORY: The dominant tree species in the vegetation canopy layer as determined from a birds-eye (aerial) view.

PEEP SITE: A small hand level.

PLANIMETER: An instrument used to measure the area of any figure by tracing the perimeter of the figure. The area of a drainage basin can be accurately calculated by tracing the perimeter of a drainage basin with a planimeter.

PLUNGE POOL: A channel-spanning pool habitat in which the scour element maintaining the depth of the pool is a channel-wide obstruction such as a bedrock falls or a debris jam over which streamflow plunges. A plunge pool must span the width of the wetted channel but need not be longer than its width.

POOL: A portion of the stream which usually has reduced surface turbulence and has an average depth greater than riffles when viewed during low flow conditions. The bowl or tub appearance of pools is the result of high flow scouring the streambed. A pool may at times contain substantial surface turbulence at the upstream end, but always has a hydraulic control present across the full width of the channel at the downstream end.

This hydraulic control functions as a dam which retains water in the pool even after streamflow ceases. This retained water is referred to as the residual pool. Residual pool depth is the difference between the maximum pool depth and the maximum depth along the downstream hydraulic control.

RANGE OF NATURAL CONDITIONS: The lowest and highest values a system could reach for any given ecological parameter. The effects of human intervention during the historical time frame are intentionally not included in the determination of the range of natural conditions.

REACH: A relatively homogenous section of stream having a repetitious sequence of habitat types and relatively uniform physical attributes such as channel slope, habitat width, habitat depth, streambed substrate, and degree of interaction with its floodplain.

REACH ENDPOINTS/STARTPOINTS: The beginnings and ends of all reaches. The endpoint of a reach is the startpoint of the reach upstream. Every endpoint occurs at the upstream end of a habitat.

RIFFLE: A portion of the stream with increased water velocity. Streamflow during low flow discharge is intercepted by partially or completely submerged obstructions to produce relatively high surface turbulence, and this turbulence often is seen as pockets of whitewater. Stream channel gradient is greater in riffles than in pools. Riffles are an inclusive term for low gradient riffles, moderate gradient rapids, and high gradient cascades.

RIPARIAN VEGETATION: Vegetation growing on or near banks of a stream or body of water on soils that exhibit some wetness characteristics during some portion of the growing season. This also includes near-stream vegetation which either offers shade to the stream or could supply the stream with large woody debris (LWD).

RIPARIAN ZONE: The area between a stream or other body of water and the adjacent upland slopes. This zone is identified by soil characteristics and distinctive vegetation. It includes wetlands, the near-shore vegetation surrounding lakes, the portions of flood plains and valley bottoms that support riparian vegetation. The riparian zone also includes those portions of the upland which have the potential to deliver large woody debris (LWD) to the stream channel.

For the purpose of a level II stream inventory, riparian zone refers to the 100 ft. strip of landscape paralleling the channel on both banks, although it is acknowledged that the true riparian zone is usually wider than these 100 ft.-wide strips.

ROSGEN STREAM TYPE: The Rosgen classification system defines stream channels based on the level of investigation. The office phase (level I) of stream inventory permits surveyors to assign a letter label (alpha class: Aa+, A, B, C, D, DA, E, F, or G) to each stream reach. These labels attempt to distinguish the broad landscape differences in stream character due to valley gradient, valley width, and the apparent sinuosity of the stream observed on 1:24,000 scale USGS maps and aerial photography. Field measurements are essential to refine these landscape-level channel designations.

ROOTS: The branching network of a plant which both anchors the plant in the ground and transports nutrients and water to the stem from the ground. Exposed roots within the bankfull channel have very little impact on streamflow.

ROOT SWELL: The portion of a tree in which the root tissues are replaces by stem tissues. This region of the tree is distinctly broader than the stem, or tree bole, above it. The majority of the mass of a tree stump is root swell. Bankfull streamflow is significantly altered by the presence of just the root swell of a tree within the bankfull channel.

SENSITIVITY: As applied to watersheds and fish stocks, is the degree of resiliency each possesses to changes in their conditions. That is, sensitivity is a reflection of how persistent certain physical or biological conditions are to different impacts on the system.

SIDE CHANNELS: A lateral (i.e., secondary) channel with an axis of flow roughly parallel to the mainstem channel. This secondary channel transports water from an upstream confluence with the mainstem channel to a downstream confluence with the mainstem channel.

The island formed by the side channel and the mainstem channel is stable and not likely to be inundated during bankfull discharge. Persistent woody vegetation other than willow is evidence that the island is stable and that the secondary channel is a side channel. In certain circumstances, woody plants may be absent from a stable island. But in those cases, a well developed soil and vegetation will be present, and the vegetation will endure bankfull discharges.

For purposes of the level II field inventory, side channels that have no flow during low flow conditions, that is, they are dry at the time of the survey, are not designated as habitats nor are they analyzed in the SMART database.

SINUOSITY: The ratio of stream channel length to valley floor length determined at the reach scale. Using a map wheel, the stream channel length is traced on a map between the two endpoints of a reach. The map wheel is then used to trace the distance between the same two points along an imaginary line occupying the middle of the valley floor. Channels with sinuosities of 1.5 or more are called meandering.

STADIA ROD: A rod divided into 0.01 ft. increments which is used to accurately determine differences in elevation.

STAFF (OFFICERS): The lead personnel from each section (e.g., Budget and Finance, Engineering, Natural Resources, Recreation, Contracting, etc.) of any management unit within the USDA Forest Service. Management units include Districts, Forests, Regions, and the Washington Office. Staff officers report directly to the line officers of their management unit. The responsibilities of staff officers include recommendations to their line officers as well as guiding the operations of programs and technical activities within their section.

STREAMFLOW: The volume of water passing through the cross-sectional area of a channel per unit time. Syn: discharge.

STREAM ORDER: A numbering convention for stream channels which reflects the degree of stream network-branching upstream of a given point along the stream. See accompanying Appendix B for an illustration.

TENSION CRACKS: Visible cracks or fractures in the surface of the soil. These fractures are the result of gravitational stresses pulling the soil apart, and these cracks are visible clues of soil instability.

TIER 1 KEY WATERSHED: A watershed containing habitat for potentially threatened stocks of anadromous salmonids or other potentially threatened fish such as bull trout.

TIER 2 KEY WATERSHED: A watershed with an area greater than 6 square miles possessing high quality water; such water is often the source for municipal water supplies.

THALWEG: The longitudinal (upstream to downstream) line of maximum depth within a stream channel. The deepest point in any channel cross section will occur in the thalweg.

TREE BOLE: The stem of the tree above its broadened base (= root swell). The tree bole is the portion of the tree harvested for lumber. Like the root swell, the tree bole of a large enough tree can substantially alter streamflow during bankfull events.

TRIBUTARY: A secondary channel system that occupies a distinct drainage basin and has a unique headwater origin. The drainage basin of a tributary is a portion of the larger drainage basin of the mainstem channel.

TURBULENCE: The motion of water where local water velocities fluctuate. The direction of flow changes abruptly and frequently at any particular location, resulting in the disruption of laminar flow. Turbulent water has an uneven surface. Subsurface water is often obscured in highly turbulent water by air bubbles entrained in the water (i.e., whitewater).

UNDERSTORY: The trees, shrubs or herbaceous species that compose the layer of vegetation below the overstory.

WATERSHED ANALYSIS: A systematic procedure for characterizing ecological processes to meet specific management and social objectives. The process integrates prehistoric and historic land use patterns with the natural processes which have shaped the landscape. Watershed analysis is appropriately applied to drainage basins of approximately 20-200 square miles.

WETLANDS: Lands where saturation with water is the dominant factor determining the nature of soil development. Water saturation influences the types of plant and animal communities living in the soil and on its surface. Wetlands possess soils or substrates that are at least periodically saturated with or covered by water. The vegetation of wetlands is distinct from the vegetation of adjoining areas that are elevated above the zone of inundation.

A GLOSSARY OF STREAM INVENTORY ACRONYMS

BFD: Bankfull depth

BFW: Bankfull width

BLM: Bureau of Land Management (an agency within the US Department of the Interior)

CFS: Cubic feet per second

DBH: Diameter at breast height (a rough measure of the age of a tree)

EPA: US Environmental Protection Agency

FL: Field length (number of characters available in a database to record a specific attribute)

FS: USDA Forest Service

FSH: Forest Service Handbook (an exhaustive information resource used by all FS units)

GIS: Geographical Information System (a digital mapping system)

IBM: FS computer network

IFIM: Instream Flow Incremental Methodology (a process for determining the minimum streamflow needed to sustain fish populations)

IRI: Integrated Resource Inventory

LWD: Large woody debris (downed woody material intercepting bankfull streamflow and large enough to remain in the system during normal flow conditions)

NSO: Natural sequence order (the numerical label for all stream habitats; it is assigned in order as the habitats are encountered)

ODFW: Oregon Department of Fish and Wildlife

R06: Region 6 (Pacific Northwest Region of the USDA Forest Service)

RD: Ranger District (each National Forest is composed of several Ranger Districts)

RM: River mile (stream channel distance measured from the stream's mouth, typically expressed in units of tenths of a mile)

SMART: Stream Management, Analysis, Reporting and Tracking (the database application in ORACLE designed specifically for level II stream inventory)

TFW: Timber, Fish and Wildlife (a cooperative venture in Washington state which includes private and public partners whose goal is to smooth the path to ecosystem management)

USDA: US Department of Agriculture (the Forest Service is an agency within this federal Department)

USDI: US Department of the Interior (the Bureau of Land Management, the National Park Service, and the Geological Survey are agencies within this federal Department)

USGS: US Geological Survey (an agency within the US Department of the Interior)

WDFW: Washington Department of Fish and Wildlife